WERNER SPALTEHOLZ

HAND ATLAS OF HUMAN ANATOMY

126
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HAND-ATLAS
OF
HUMAN ANATOMY
BY
WERNER SPALTEHOLZ
IN THREE VOLUMES

TRANSLATED INTO ENGLISH BY
LEWELLYS F. BARKER

HAND-ATLAS
OF
HUMAN ANATOMY

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Preface to the Thirteenth Edition in German.

As an appendix to the section on the bones I have added to the first volume of the 13th German edition of my Hand-Atlas some eighteen roentgenograms made from living persons, by Dr. Gustav Bucky, Director of the Roentgenological Department of the Virchow Hospital in Berlin. They have been taken in large part from a voluminous roentgenological atlas that Dr. Bucky and I have been engaged in preparing during several years past and which will soon be published by Paul B. Hoeber of New York; a few of the roentgenograms have been especially prepared at my request. I desire here to give my heartiest thanks both to my colleague Dr. Bucky for the preparation of the roentgenograms, and to Paul B. Hoeber for permission to use them. I have laid great stress upon the most careful reproduction of these photographs; the clichés have been prepared by Schelter and Giesecke, A.G., Leipzig, under my continuous control and to my entire satisfaction.

Since the interpretation of roentgenograms is often very difficult for the unaccustomed eye I have given especial care to the preparation of the explanatory diagrams that accompany them. These diagrams have been drawn by myself according to the principles laid down in the "Preliminary Remarks to the Interpretation of Roentgenograms." I have made the attempt to make the perspective relations of the contours of the bones clearly understandable in this way. I have thus been able in the tracings to produce a certain plastic effect or at least to make clear the reciprocal depth relations of the single contours.

W. Spalteholz.

Structure of the Bones.

The **skeleton** *(sceleton)* is composed of the *bones (ossa)*, of their *cartilages (cartilagines)*, and of the *ligaments (ligamenta)*, which unite the bones with one another and with the cartilages. The number of bones in the adult (exclusive of the small bones of the ear and the sesamoid bones) is two hundred.

Structure of the Bones.

The **bones** (see figures I and II) are very firm, hard structures, whitish in color though somewhat yellow or red according to their content in blood. They consist, in the main, of the *bony substance (substantia ossea)* and of the *bone marrow (medulla ossium)* lying within them. The bone substance determines the form of the bones but it is always covered; for the most part it is covered externally by a membrane, the *periosteum*, rich in blood vessels and nerves; through the mediation of this, the union of the bones with the ligaments, with the tendons and muscles, as well as with other neighboring structures, is established. In some places the bony substance goes over directly into connective substances of other kinds; at the joint slits the *joint surface (facies articularis)* is usually covered by *joint cartilage (cartilago articularis)* of different structure.

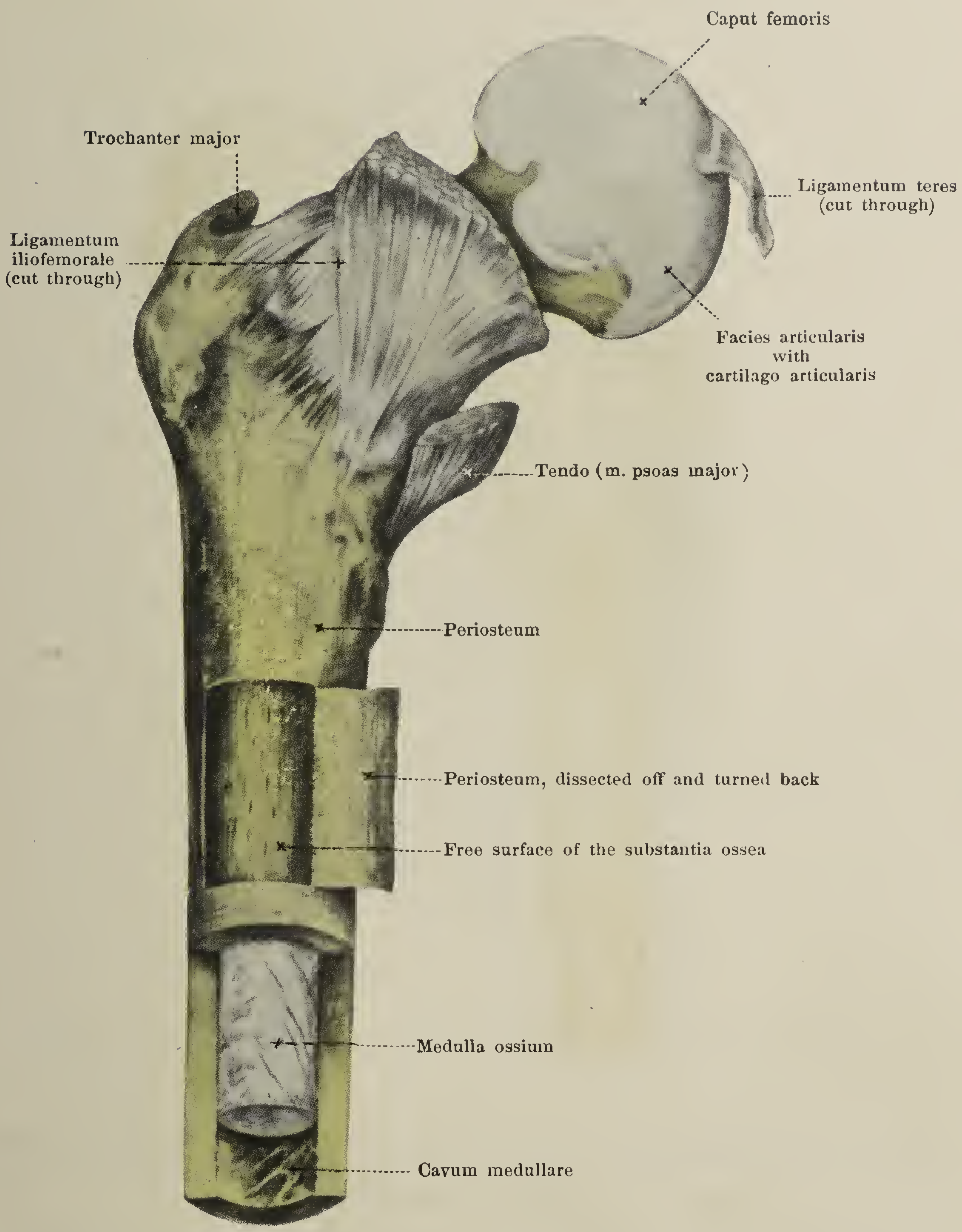
Bone substance (see figures II—XVIII) alone remains over after destruction of the uncalcified soft parts of the bone by bacteria (putrefaction) or by treatment by chemical methods (maceration). Next to the teeth it is the hardest tissue of the body and is found (recognizable by the naked eye) in the human body in two forms: (1) as a tough rounded mass, *substantia compacta*, of *solid bony tissue*, especially in the middle portions of the tubular bones of the extremities, and (2) as a loosely structured mass consisting of thin plates and columns, *(substantia spongiosa)* or *spongy bony tissue* in the end pieces of the tubular bones of the extremities as well as in the other bones. The two forms go everywhere directly and inseparably over into one another, are in the whole bone and in its single parts arranged essentially according to the mechanical laws based upon the demands made upon them and show, accordingly, in the single bones a characteristic behavior. This arrangement is recognizable with variable distinctness in cross sections of the bones and in polished preparations, in decalcified bones that have been made transparent and in rœntgenograms (see, for example, figures IV, V, XIV, and 328a).

The outermost layer of the bony substance, the *substantia corticalis*, is, in the short bones and in the terminal pieces (epiphyses) of the tubular bones, formed of a thin layer of substantia spongiosa, in the middle portions (diaphyses) of the tubular bones and in the other bones, of a strong layer of substantia compacta (see figures IX—XVIII).

The substantia compacta, in especially thick masses, forms the walls of the middle piece of the tubular bones of the extremties where it surrounds like a mantle a large unitary space, the *medullary cavity (cavum medullare)* (see figures I and III—V). This cavity is directly connected with the innumerable small spaces that lie between the columns of the substantia spongiosa—spaces that communicate with one another.

The **bone marrow** (see figure II) is a soft mass that completely fills the medullary space and the small spaces of the substantia spongiosa of all the bones; it is found also in the larger Haversian canals. According to the varying macroscopic appearances (due to the varying content in fat), we distinguish the *red bone marrow (medulla ossium rubra)*, which is very soft and semifluid and the *yellow bone marrow*, or *fat marrow (medulla ossium flava)*, which resembles subcutaneous fatty tissue. In the foetus and in the new-born one finds only red marrow in all of the bones. But, even in childhood, a fatty change in the marrow begins in the periphery of the extremities and extends proximalward toward the trunk so that, in the adult, all the short and the long bones of the extremities contain almost exclusively yellow marrow; this is true also of the middle portion of the clavicle. On the other hand, red marrow continues to exist throughout the whole of life in the bones of the trunk and of the skull and it is also often met with in the proximal portions of the humerus and the femur (see figure II). In older and severely ill persons the fat may vanish entirely from the yellow marrow; the marrow then becomes gelatinous and of a reddish yellow color and is called *gelatinous bone marrow (medulla ossium gelatinosa).*

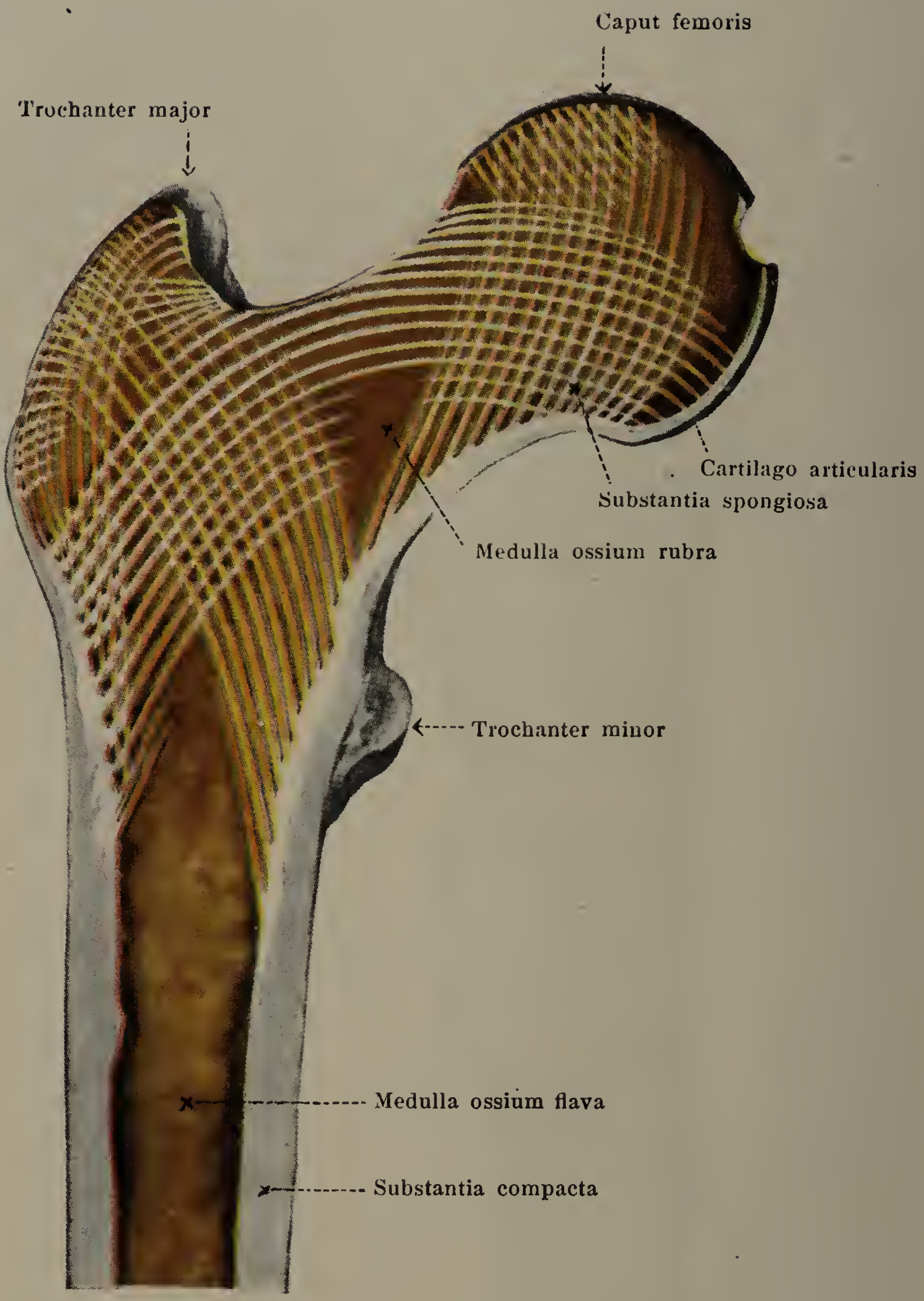
The substantia compacta is penetrated by numerous small tubules *(Haversian canals)* (see figure VIII). These are more or less completely filled by the blood vessels that run through them, usually of the structure of capillaries, but they may contain also small amounts of fat and of marrow tissue. These canals all communicate with one another, run in the tubular bones mainly in the longitudinal direction of the bones, are connected with one another by a large number of transverse canals and, on the external and internal surface of the bones, open into the nutrient canals *(canales nutricii)*. Their arrangement and their size relations are illustrated in figure VIII. The columns of the spongiosa do not contain Haversian canals.


Caput femoris
Trochanter major
Ligamentum teres (cut through)
Ligamentum iliofemorale (cut through)
Facies articularis with cartilago articularis
Tendo (m. psoas major)
Periosteum
Periosteum, dissected off and turned back
Free surface of the substantia ossea
Medulla ossium
Cavum medullare

I. Proximal part of a freshly prepared right femur of an adult, anterior view.

A piece of the periosteum has been dissected off and turned back.

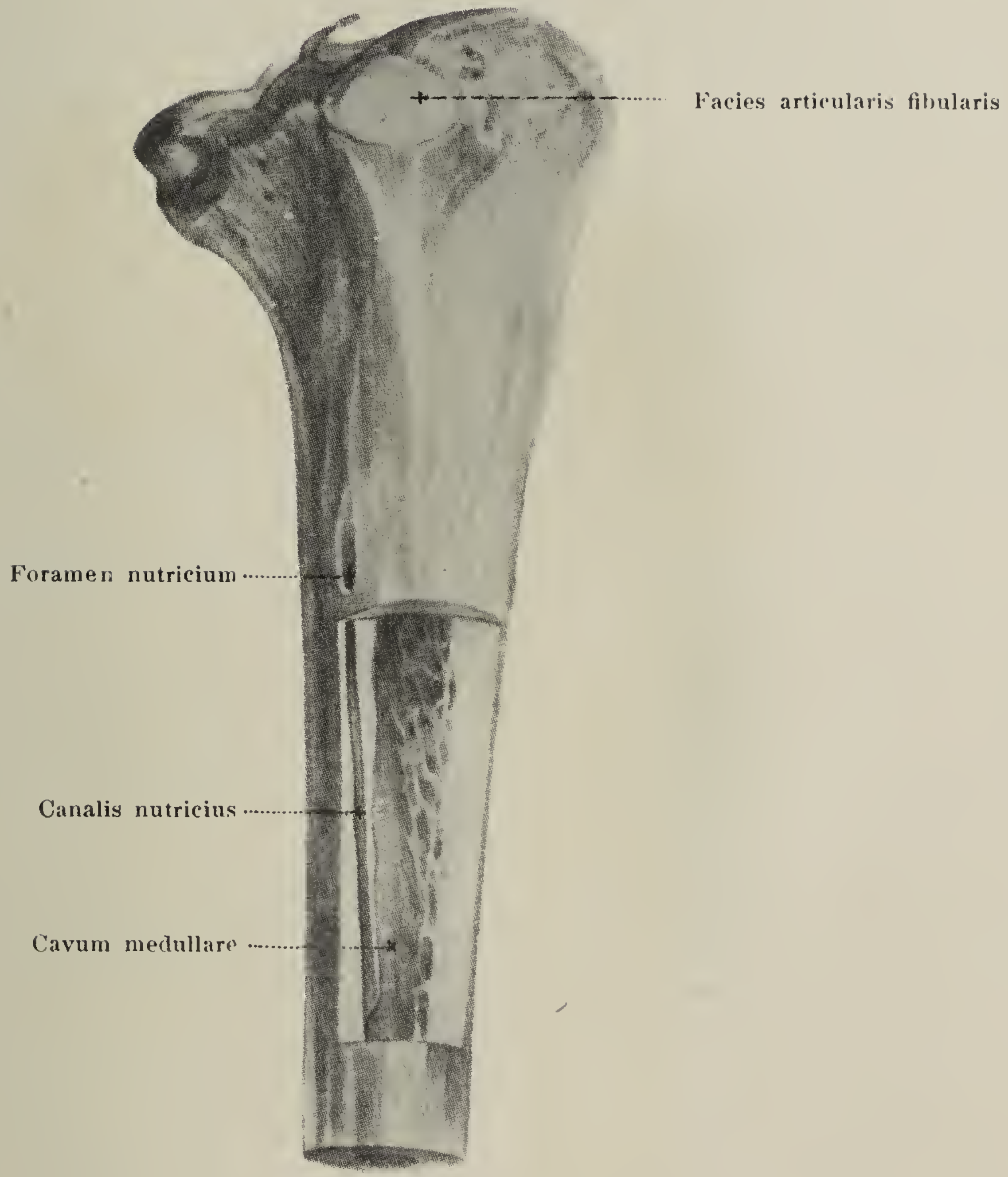
In the distal portion, the anterior half of the substantia compacta has been sawed away and the marrow exposed; from the marrow a small piece has been removed so that the marrow cavity is made visible.



II. Proximal part of freshly prepared right femur of an adult,

Frontal section-made with a saw. Posterior half viewed from in front.

(The lines drawn in the substantia spongiosa are schematic.)



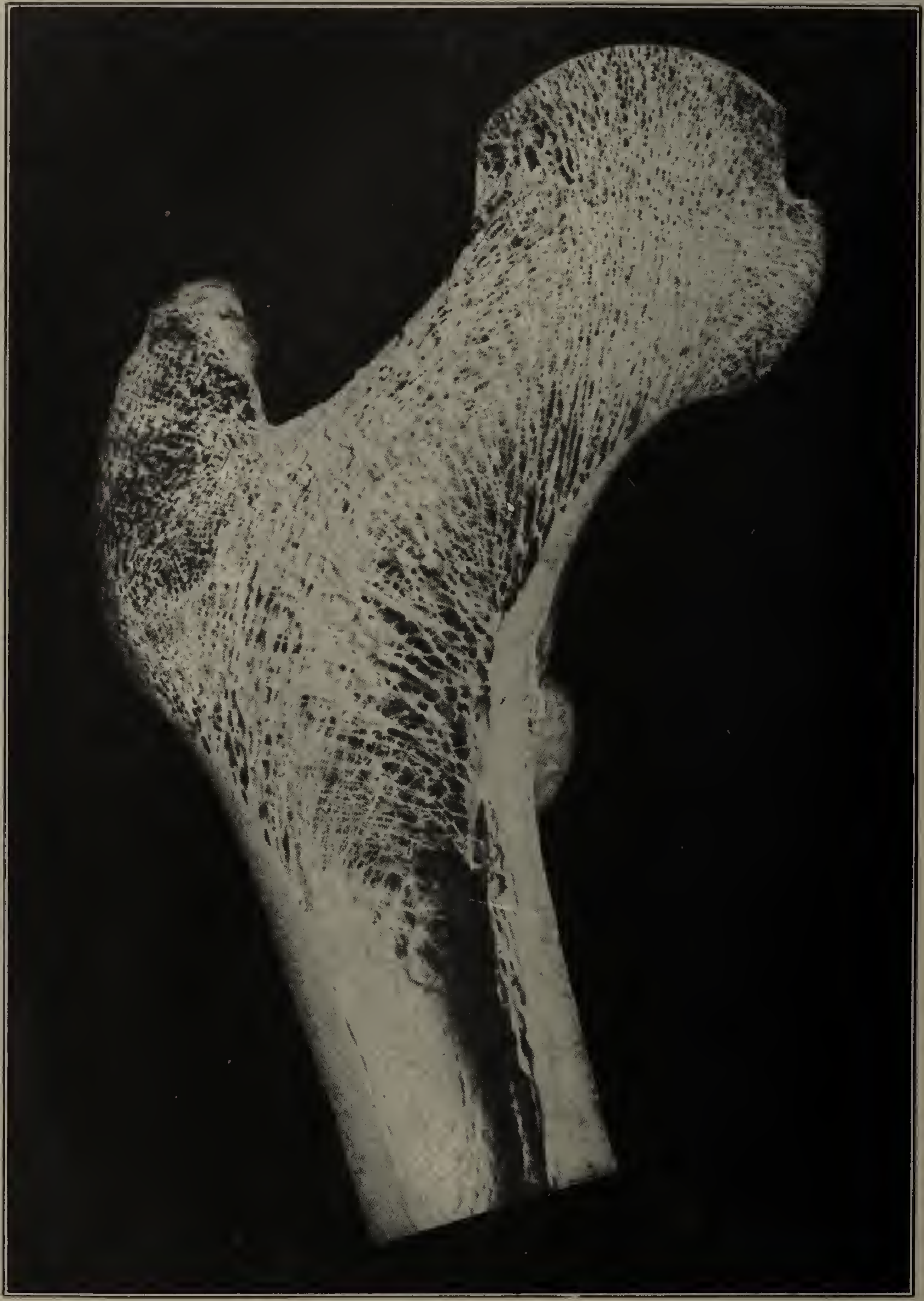
III. Proximal half of the right tibia of an adult,

viewed from the back and the side.

A piece of the substantia compacta has been sawed out in order to show the course of the canalis nutricius from the surface to the marrow cavity.

Structure of the Bones (Continuation).

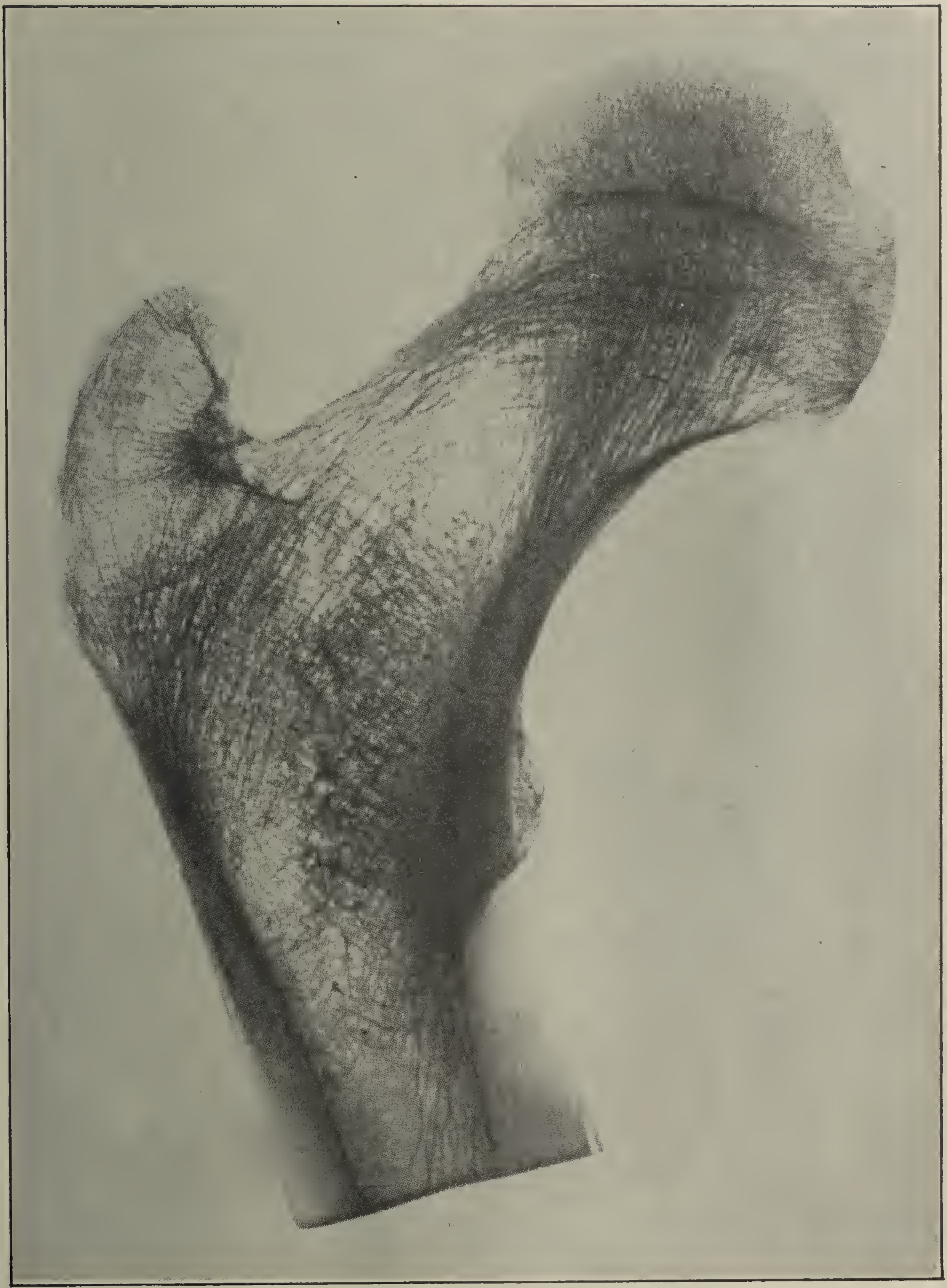
On the surface of most bones one can see one or several larger openings, *foramina nutricia*, from each of which a canal, *canalis nutricius*, leads into the marrow cavity or into the spaces of the substantia spongiosa. These canals are lined by a continuation of the periosteum and contain the *vasa nutricia*, vessels, which serve essentially for the nutrition of the bones, as well as vasomotor nerves. In the diaphyses of the tubular bones these canals, owing to uneven growth of the two bony end-pieces, perforate the compacta at a very acute angle and are therefore relatively long.



IV. Proximal end of the macerated right femur of an adult, sawed through in frontal section, in the natural state.

Dorsal half, viewed from the ventral surface.

Size, 1 : 1.

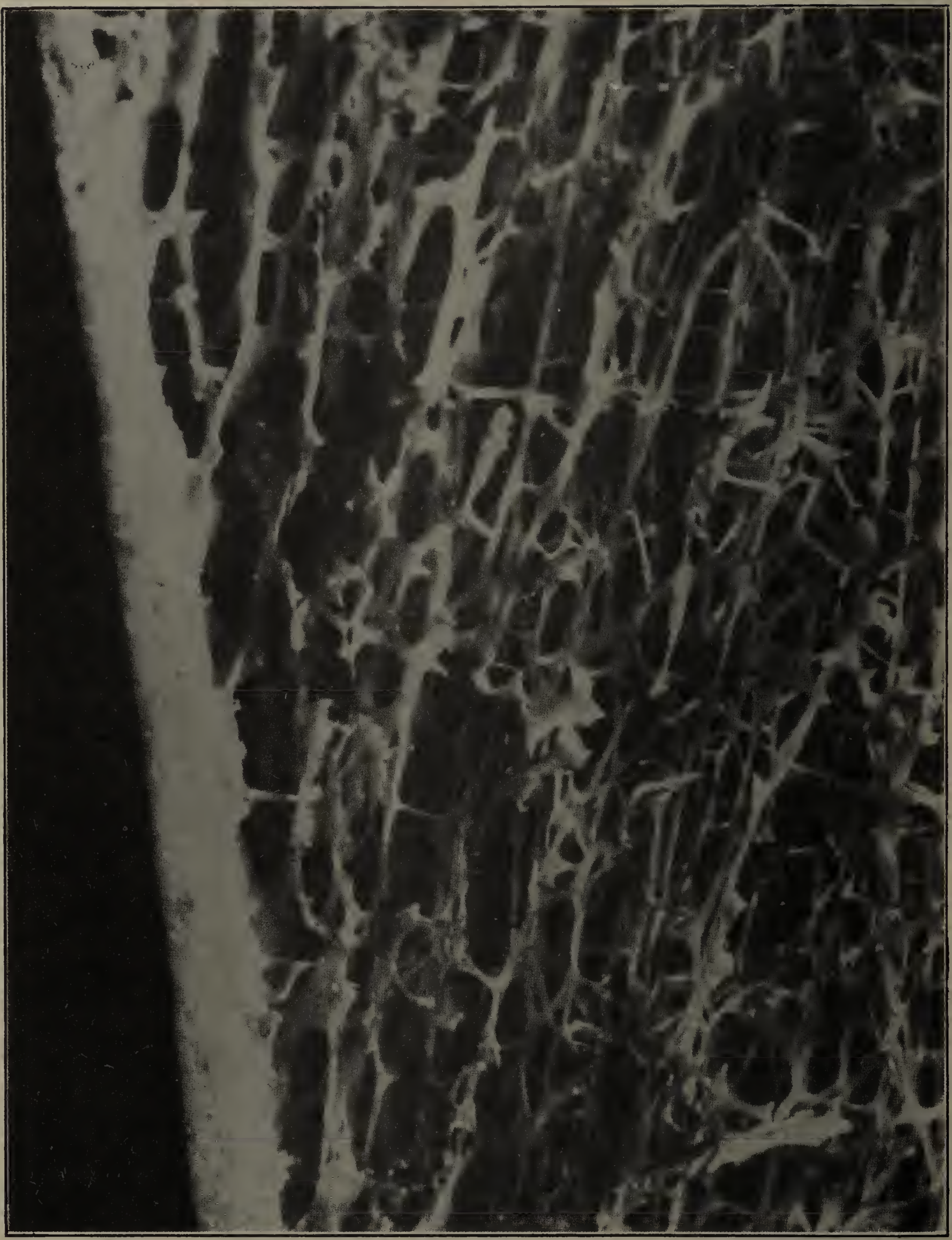


Phot. M. Schmetz.

V. Proximal end of the macerated right femur of an adult,

sawed through in frontal section, decalcified and made transparent.
Dorsal half, viewed from the ventral surface.

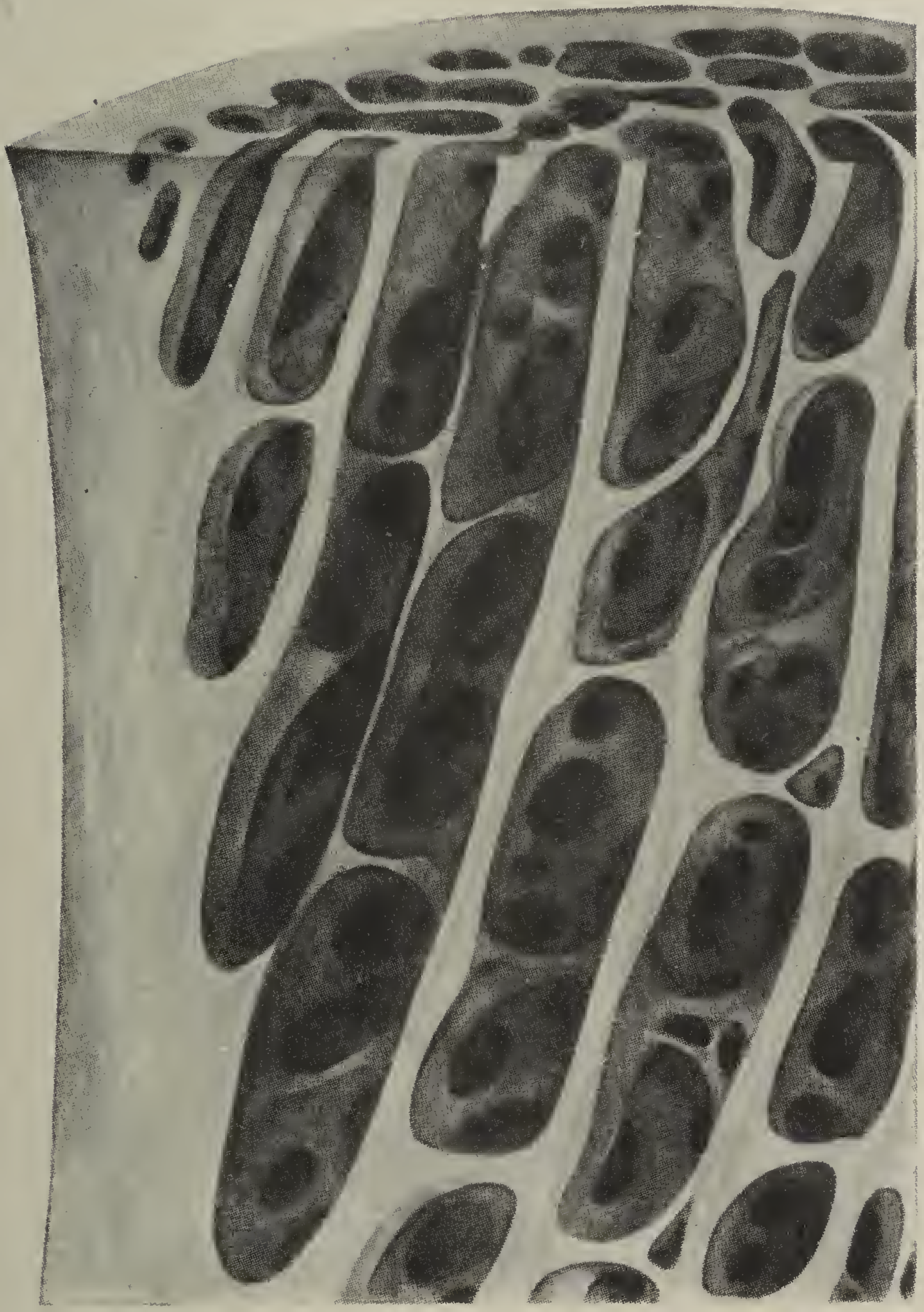
Size. 1 : 1.



VI. Distal portion of the body of the macerated right tibia of an adult,

sawed through in frontal section. Dorsal half, viewed from the ventral surface.

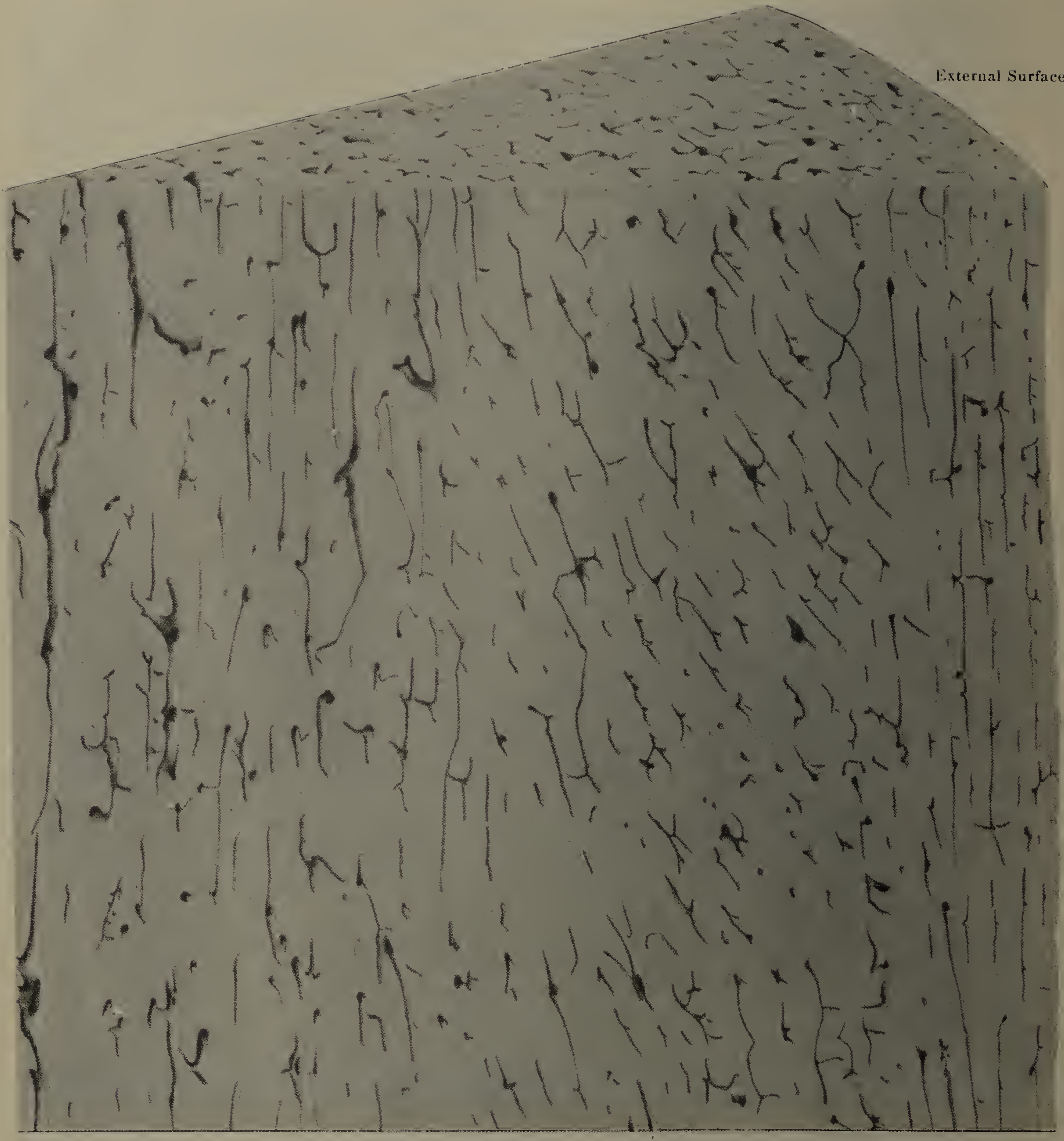
Size, 8 : 1.



VII. Relation of the substantia compacta and the substantia spongiosa

A piece of the bony structure represented in figure VI has been further enlarged and schematized.

Size, about 10 : 1.

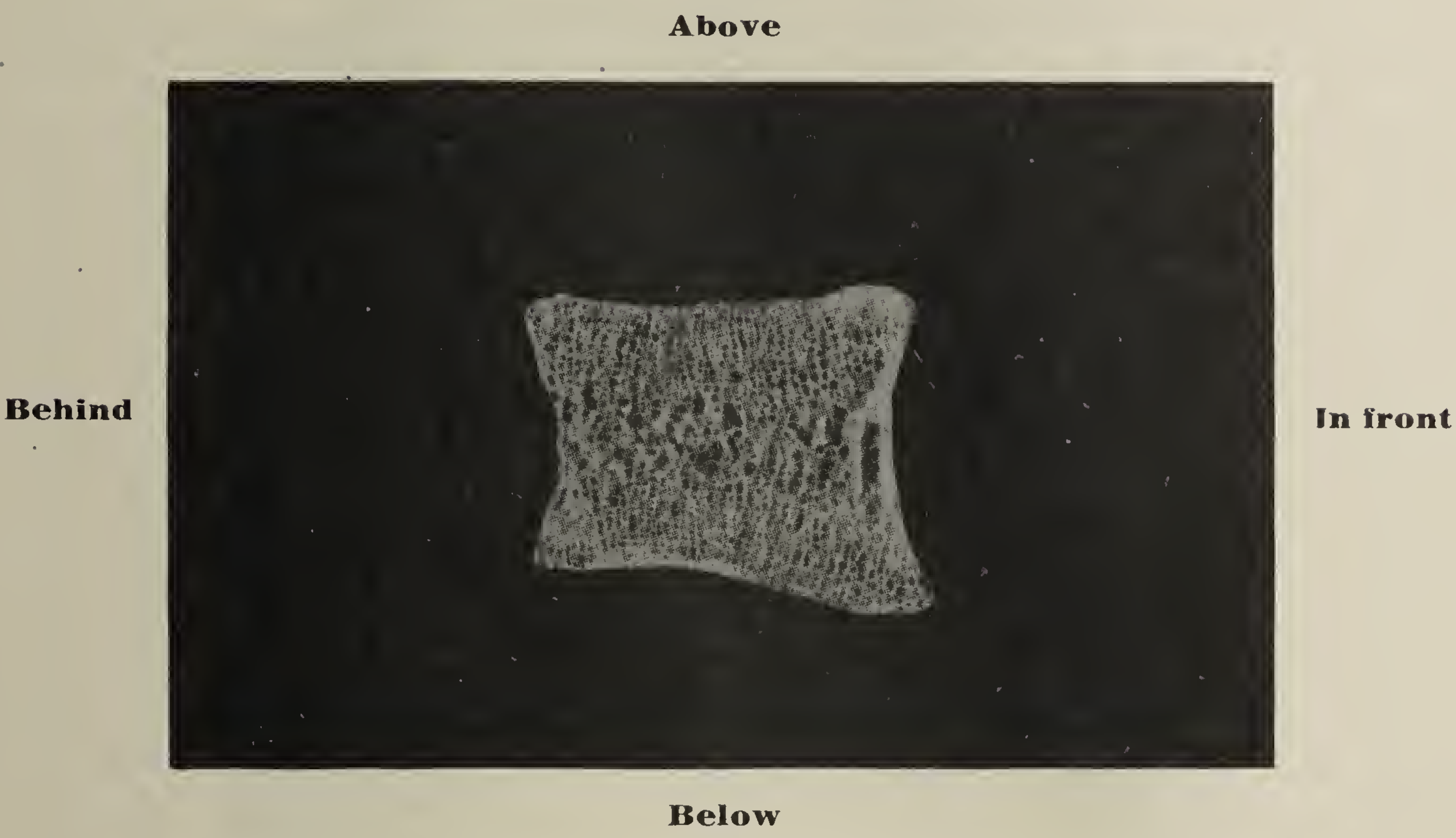


Dr. Etzold.

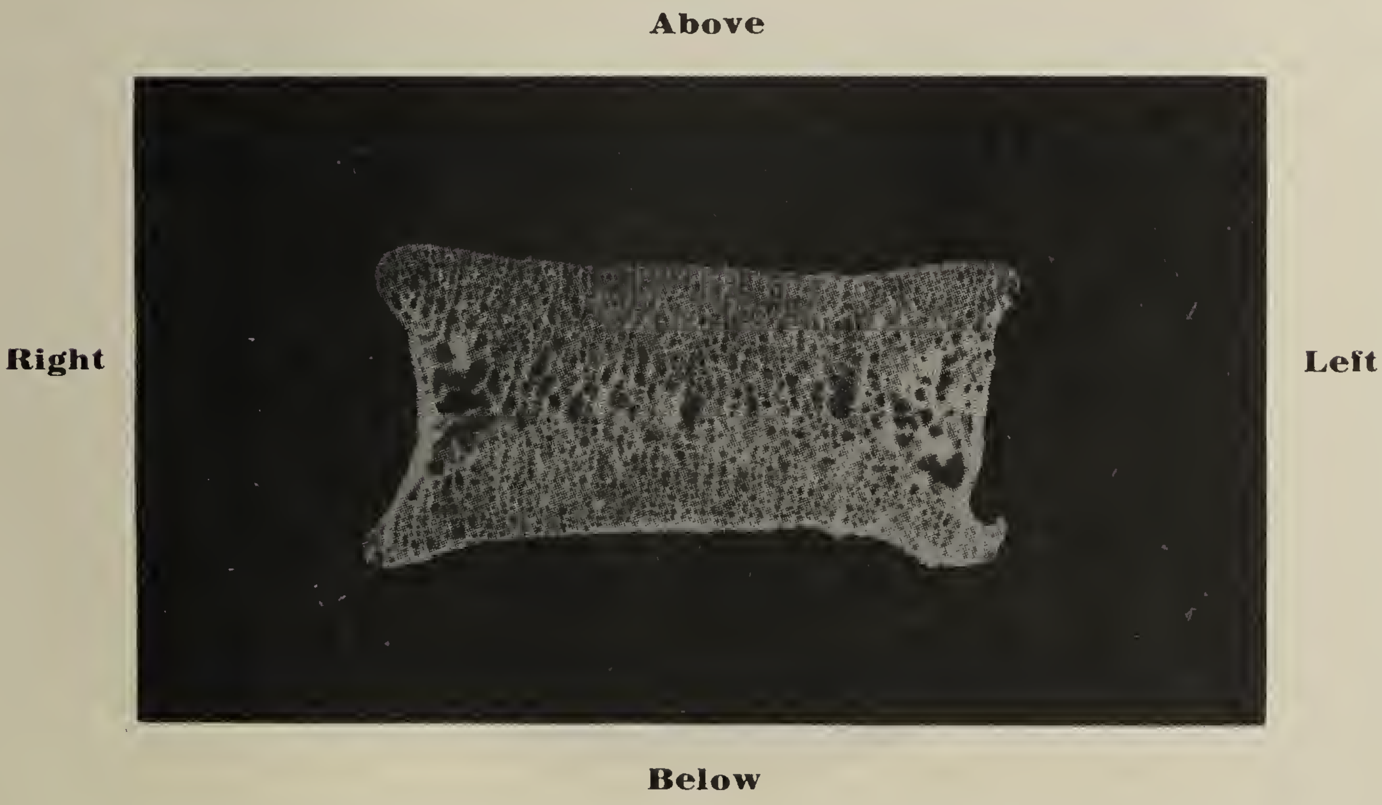
VIII. A sector of the substantia compacta of a macerated femur of an adult,

after polishing. Size, 12 : 1.

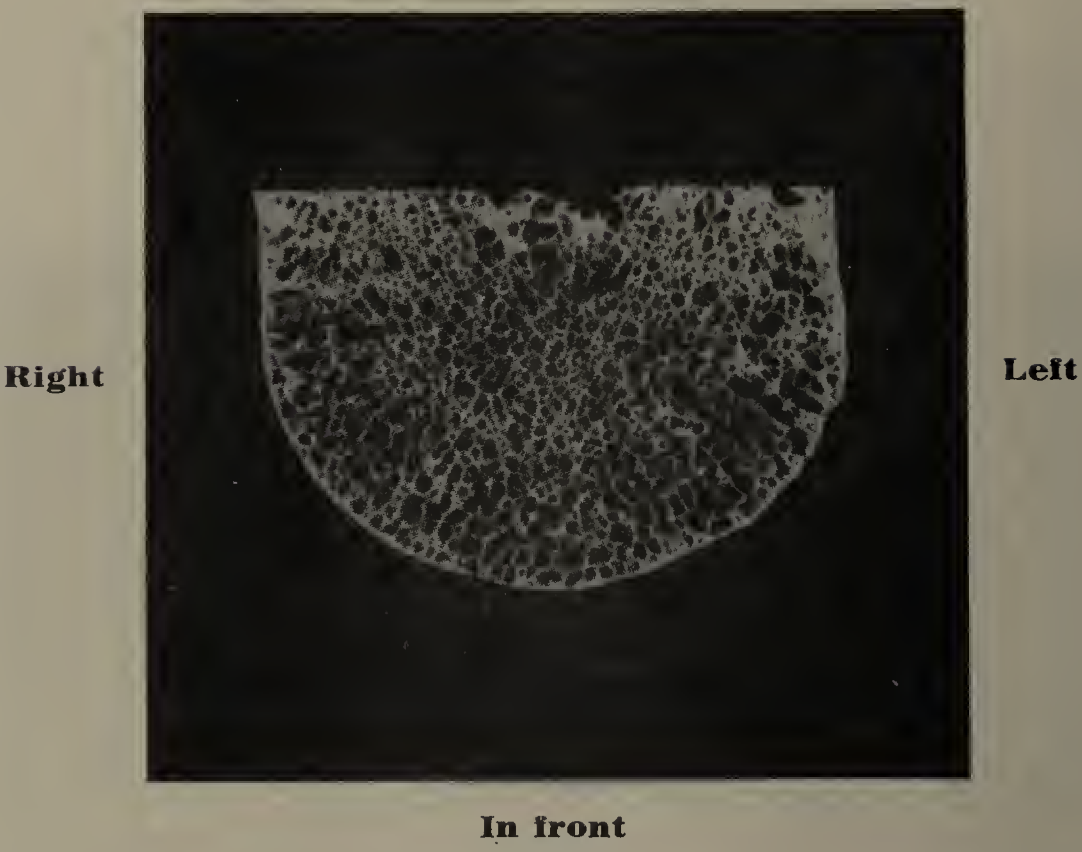
The small spaces shown are the Haversian canals.



IX. Lumbar vertebra, *vertebra lumbalis,*
ground sagittal section, from the side.

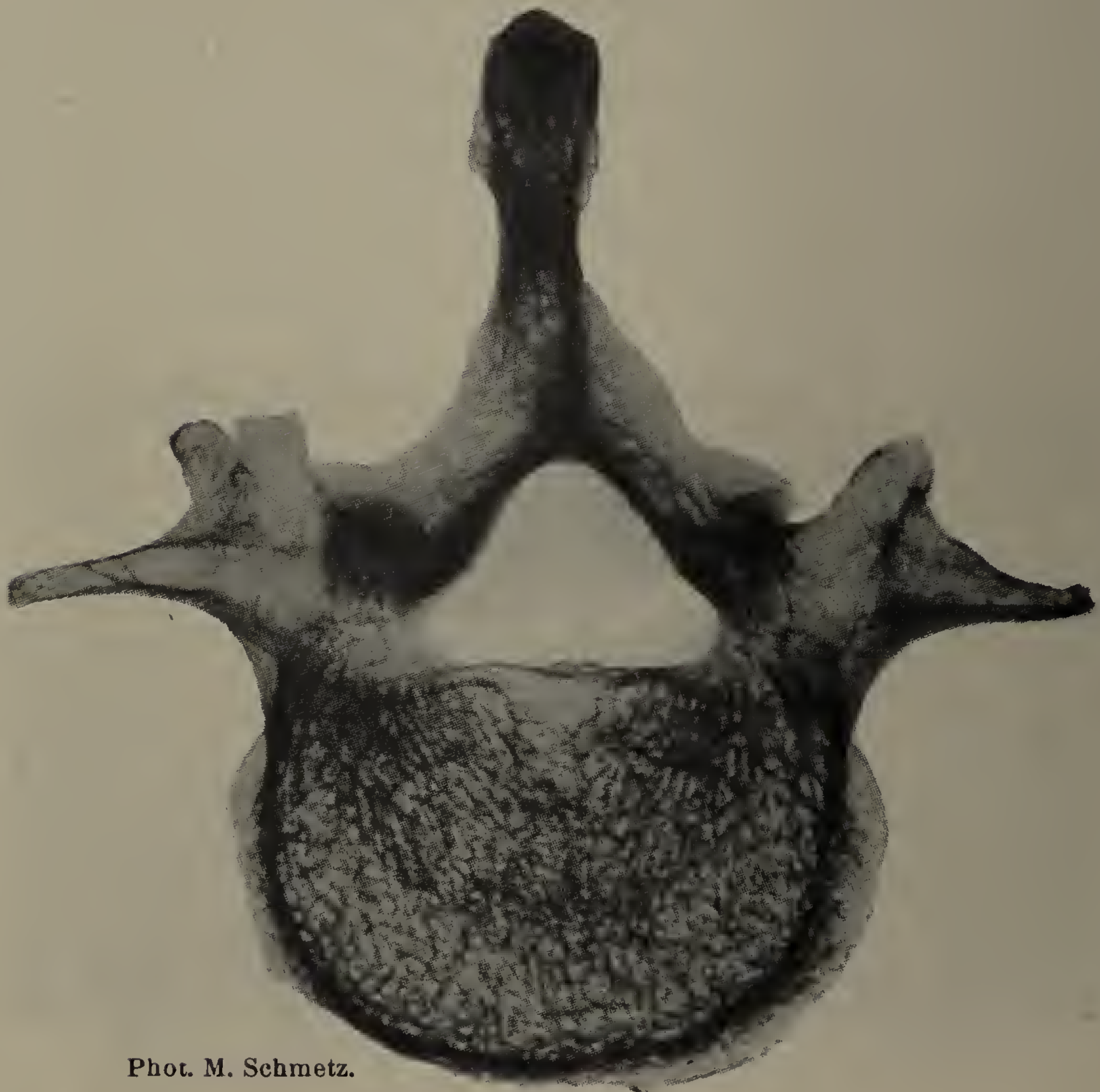


X. Lumbar vertebra, *vertebra lumbalis,*
ground frontal section, from in front.



XI. Lumbar vertebra, *vertebra lumbalis,*

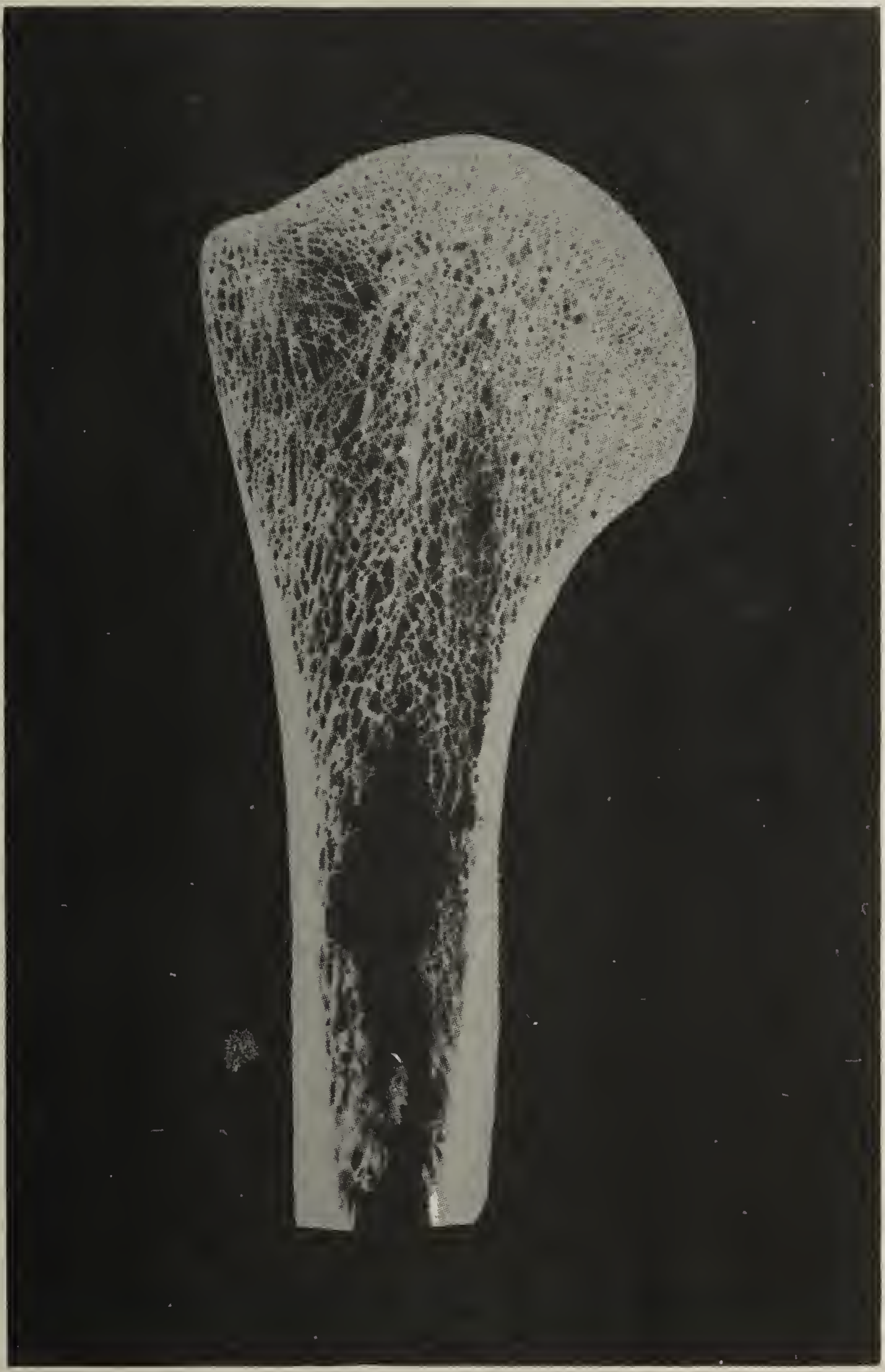
ground horizontal section, from above.



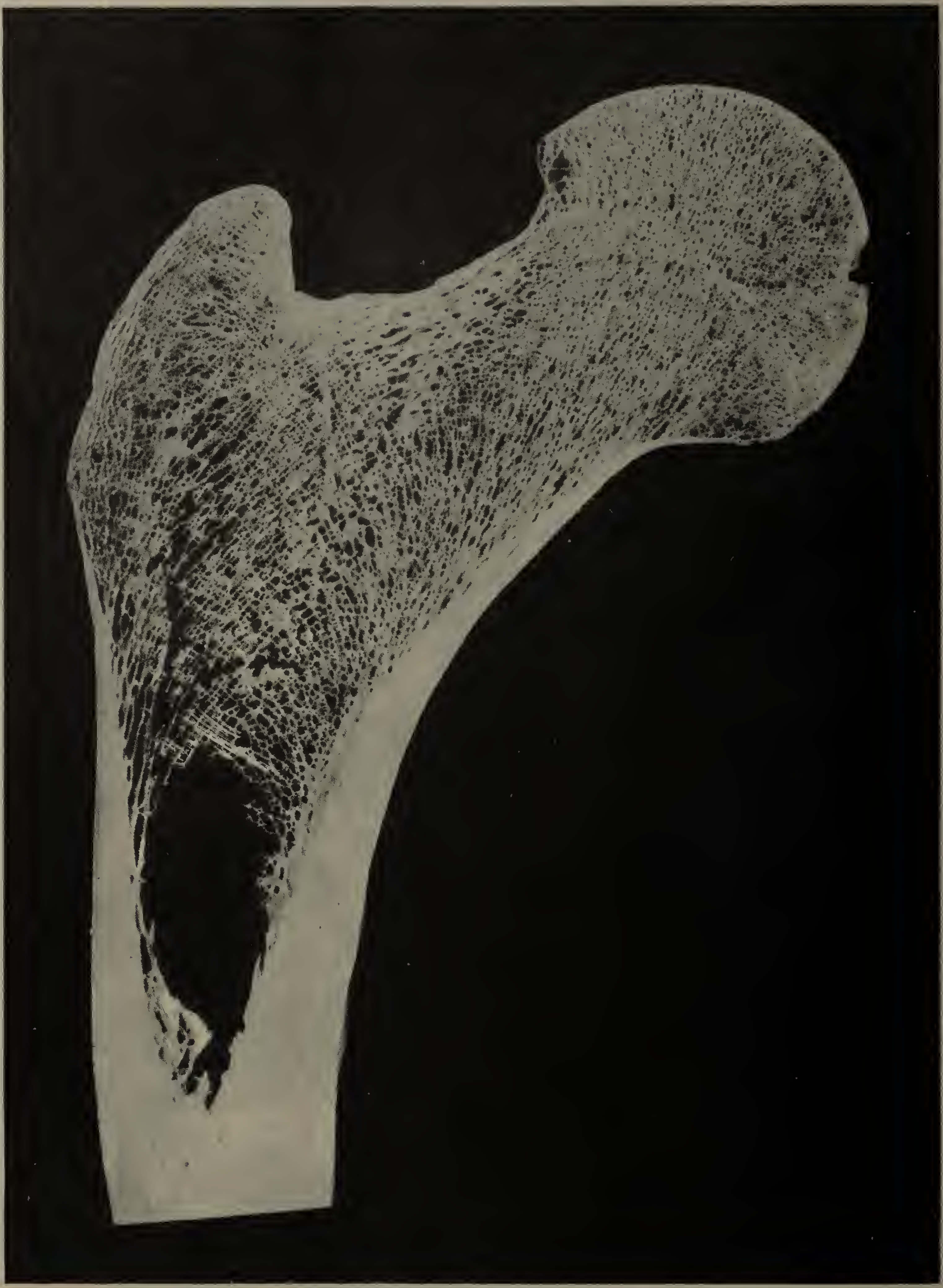
XII. Fourth lumbar vertebra, *vertebra lumbalis IV,*

decalcified and made transparent, viewed from above.

The cranial and caudal parts of the vertebral body have been sawed off in horizontal section, so that only a disc approximately 1 cm in thickness remains.

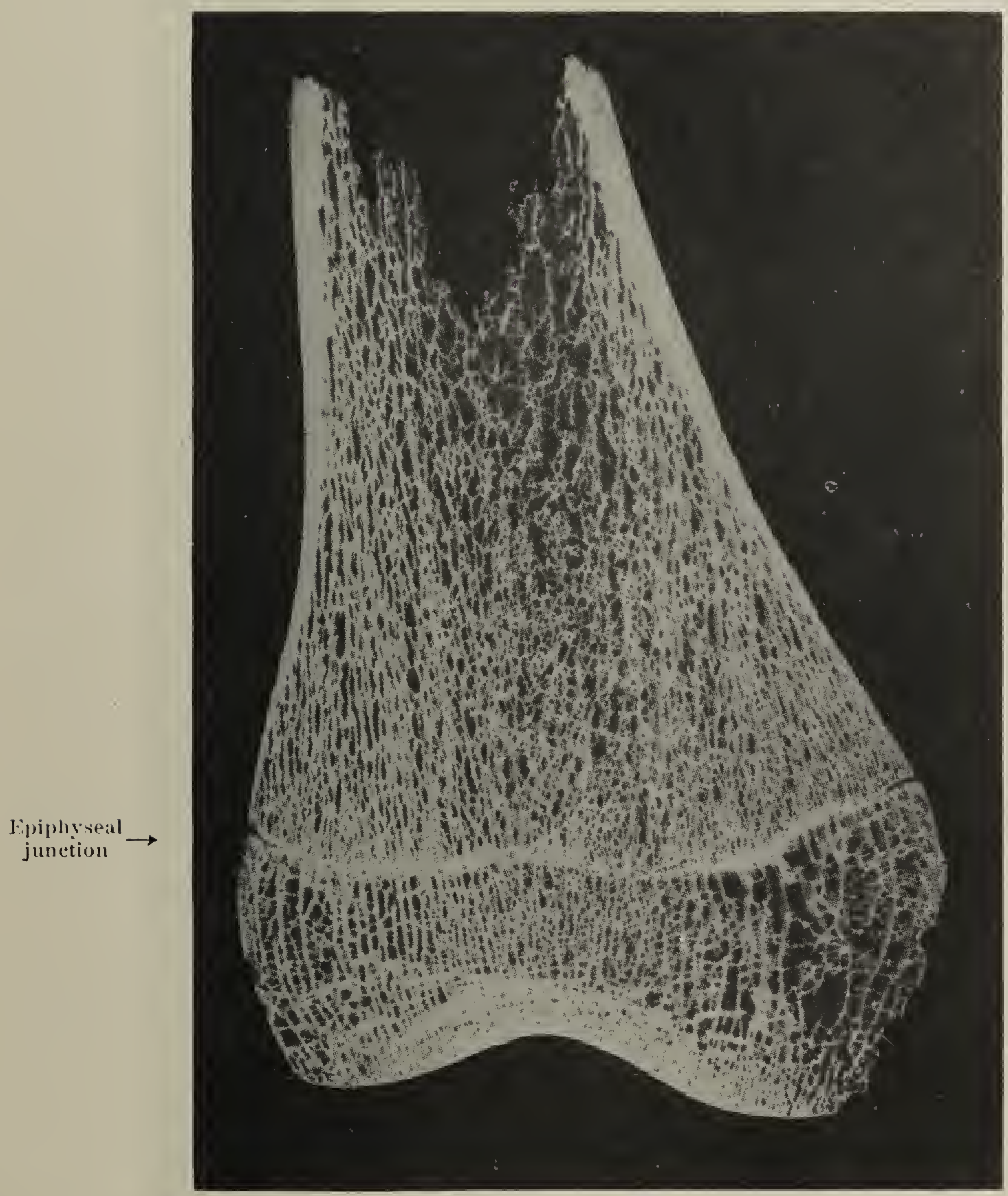


XIII. Right upper arm bone, *humerus,*
upper extremity,
ground frontal section, from in front.

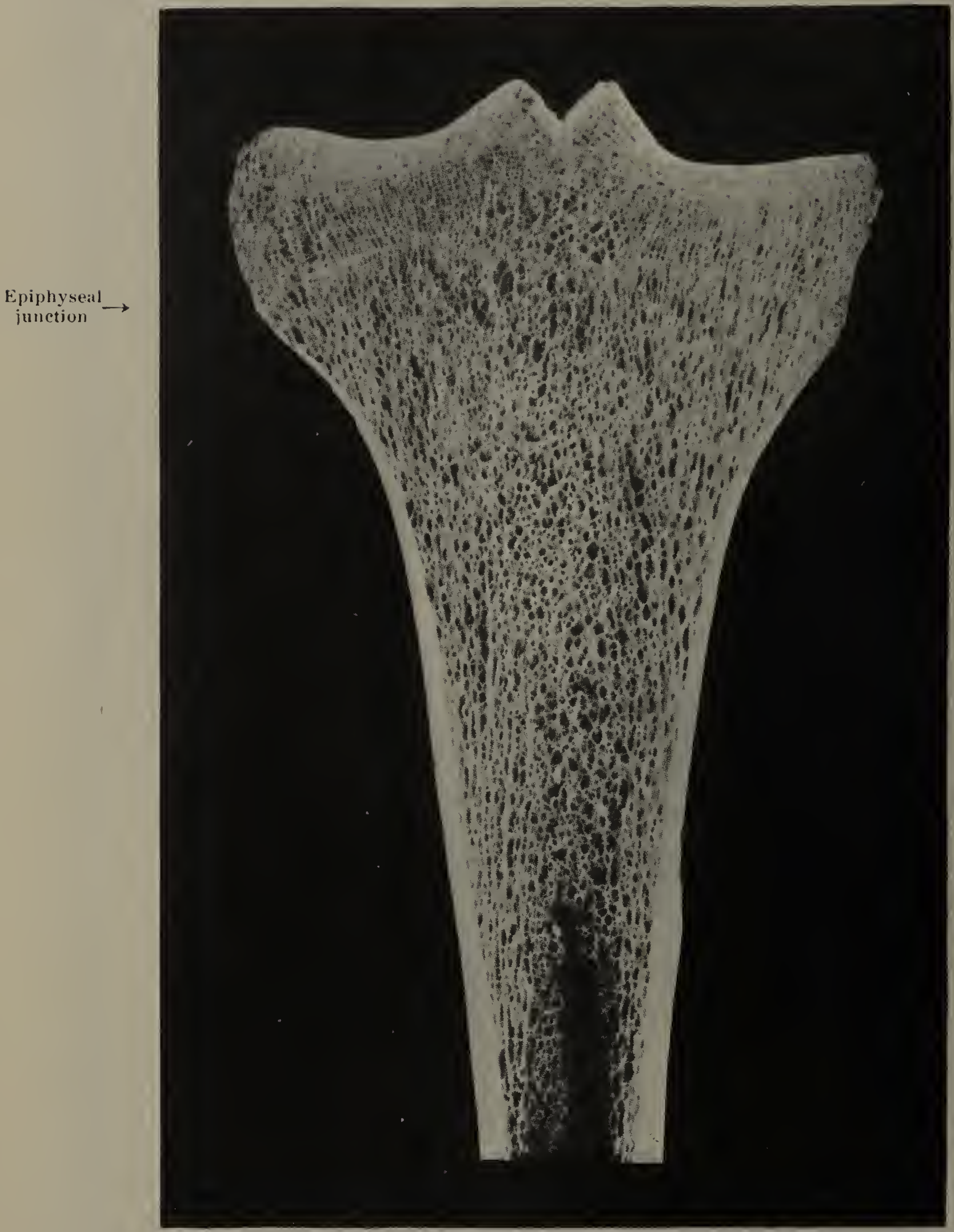


XIV. Right thigh bone, *femur,*

upper extremity, .
ground frontal section, from in front.

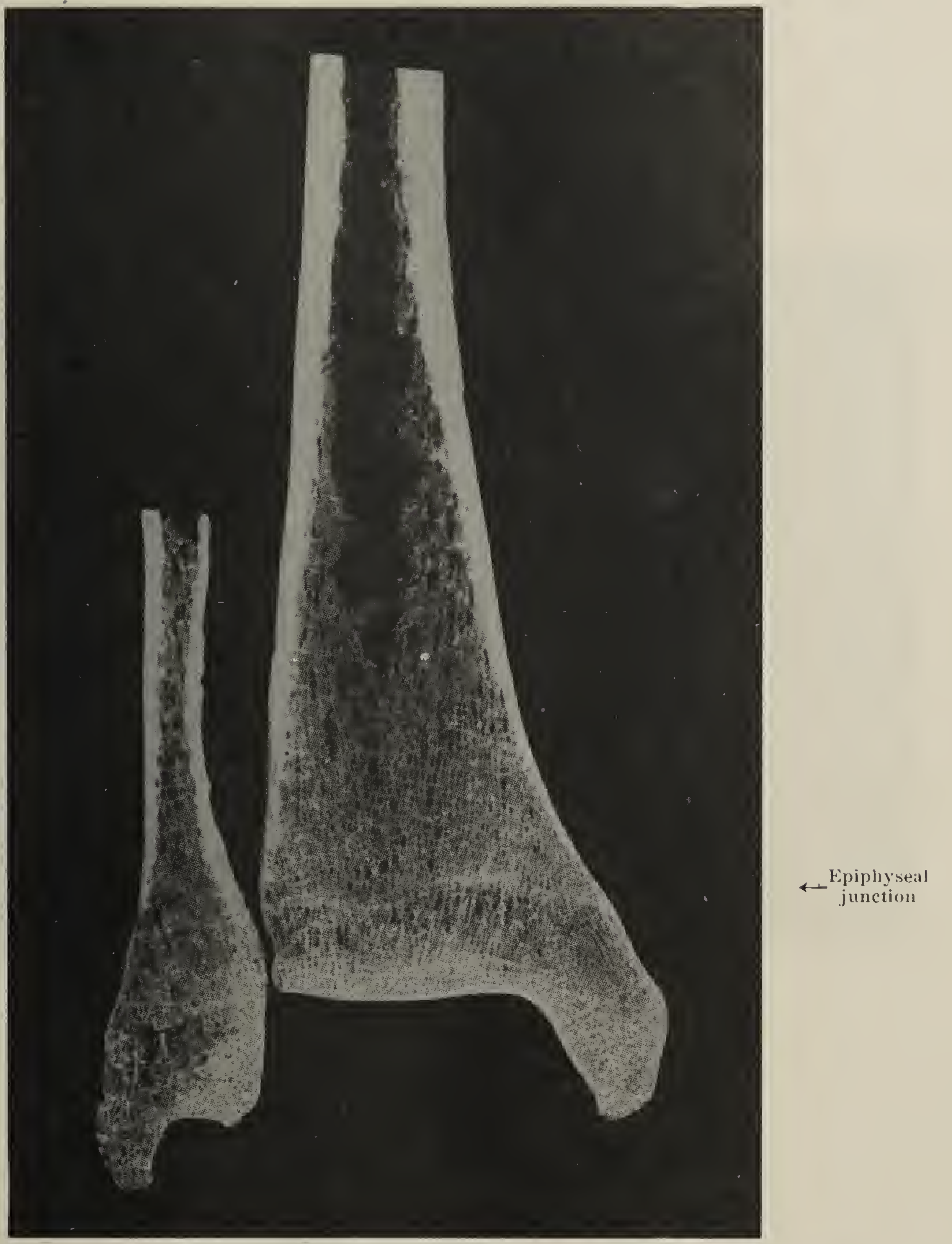


XV. Right thigh bone, *femur,*
inferior extremity,
ground frontal section, from in front.



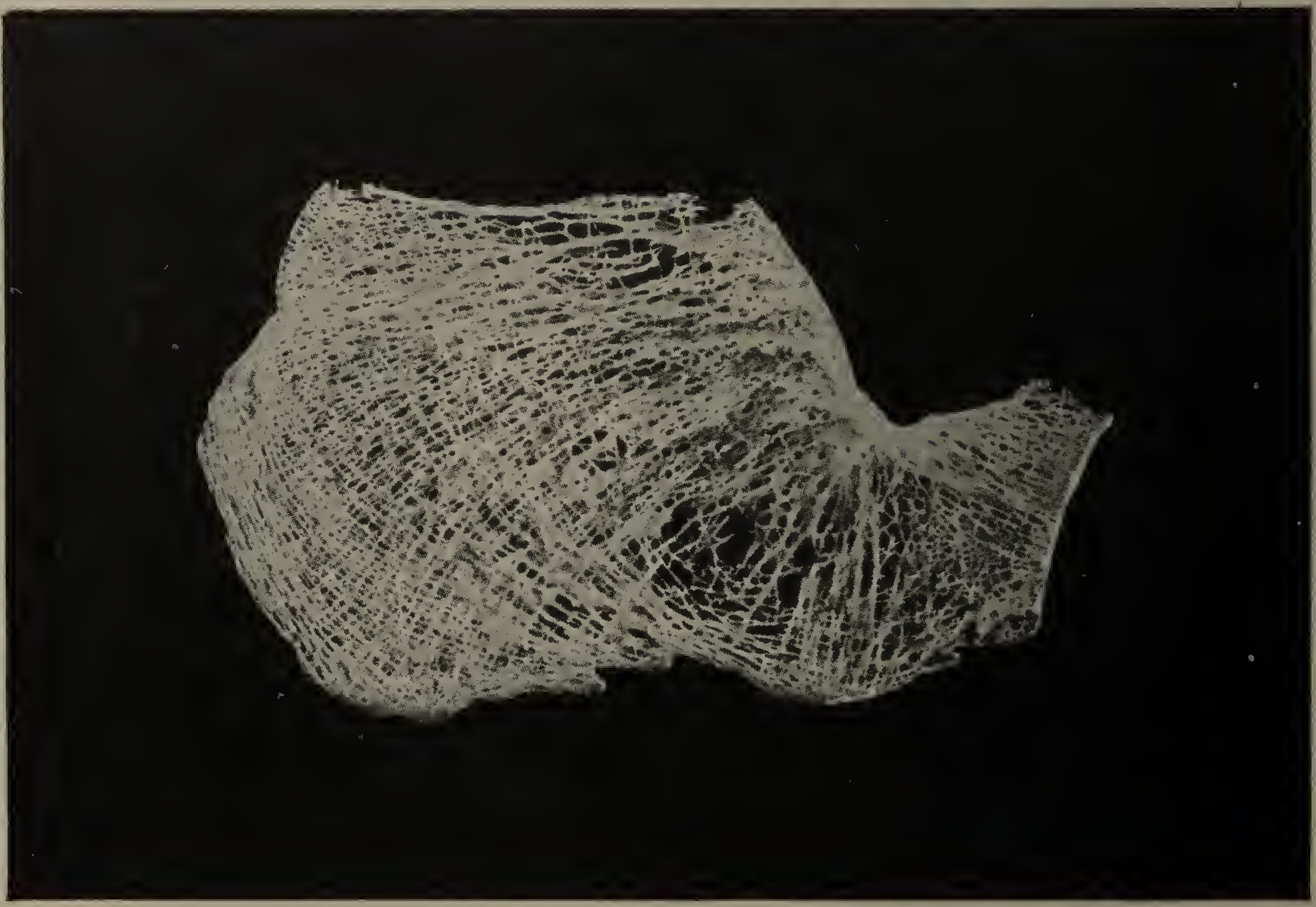
XVI. Right shin bone, *tibia,*

upper extremity,
ground frontal section, from in front.



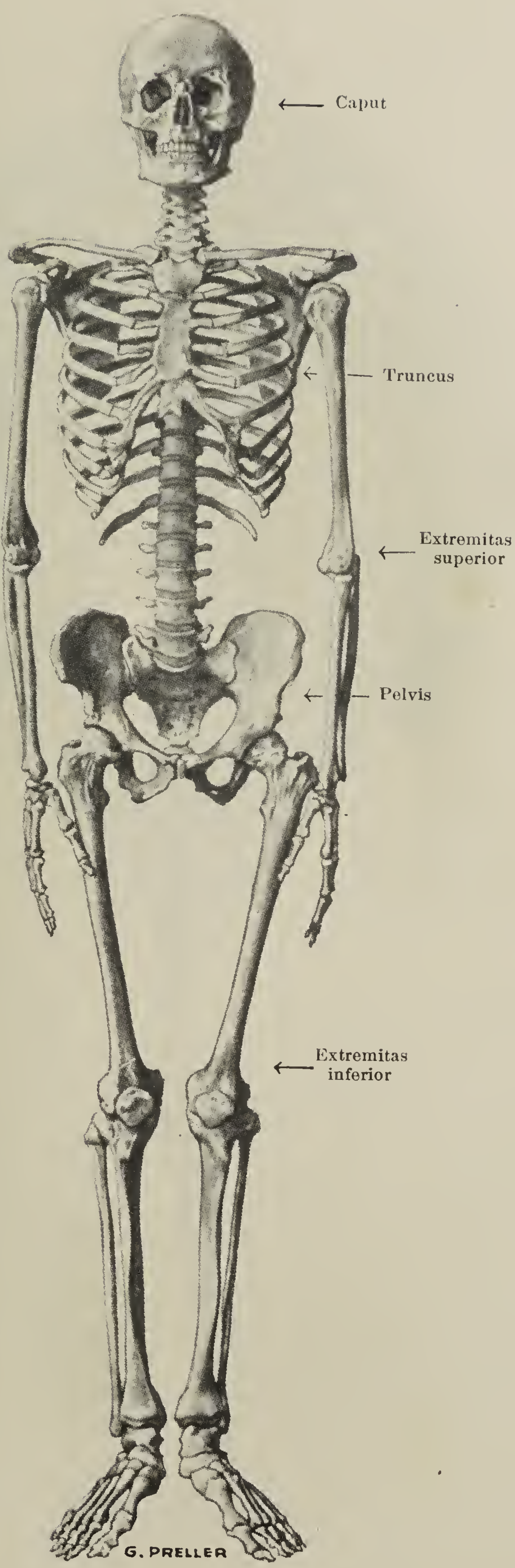
XVII. Right shin bone and calf bone,

tibia et fibula, inferior extremity,
ground frontal section, from in front.

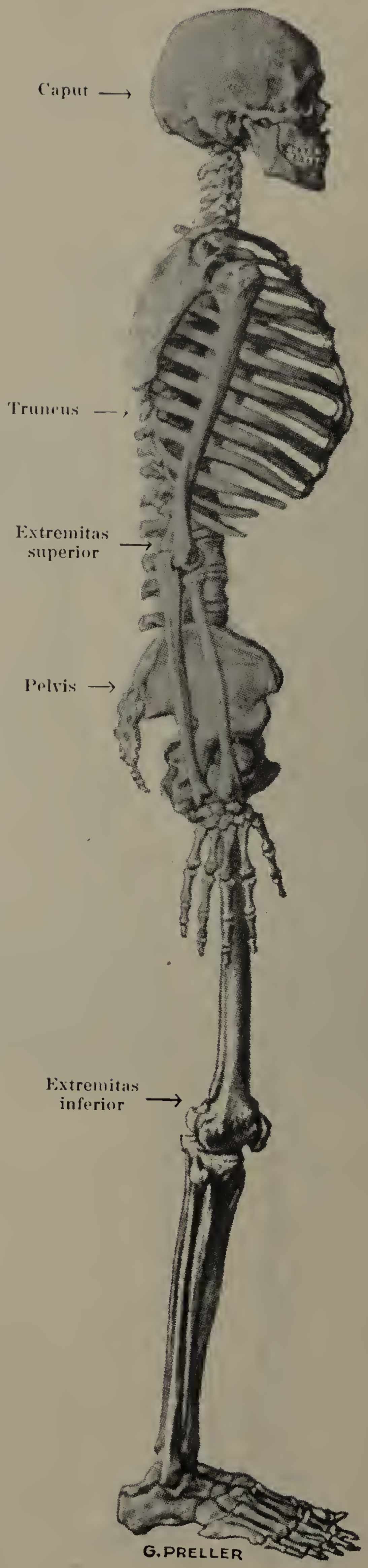


XVIII. Right heel bone, *calcaneus,*

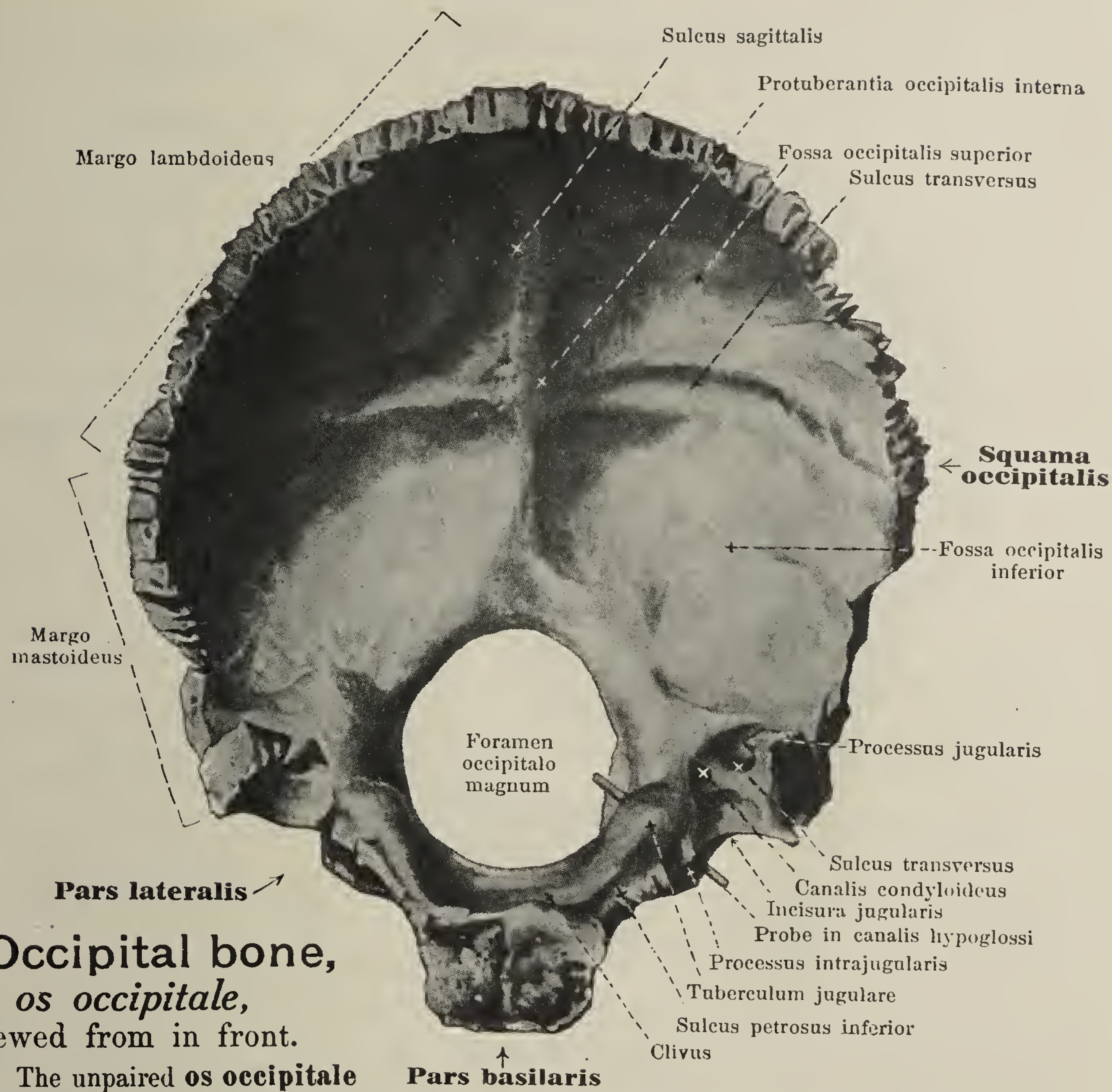
ground sagittal section, viewed from the side.



1. **Skeleton,** *sceleton,* anterior view.



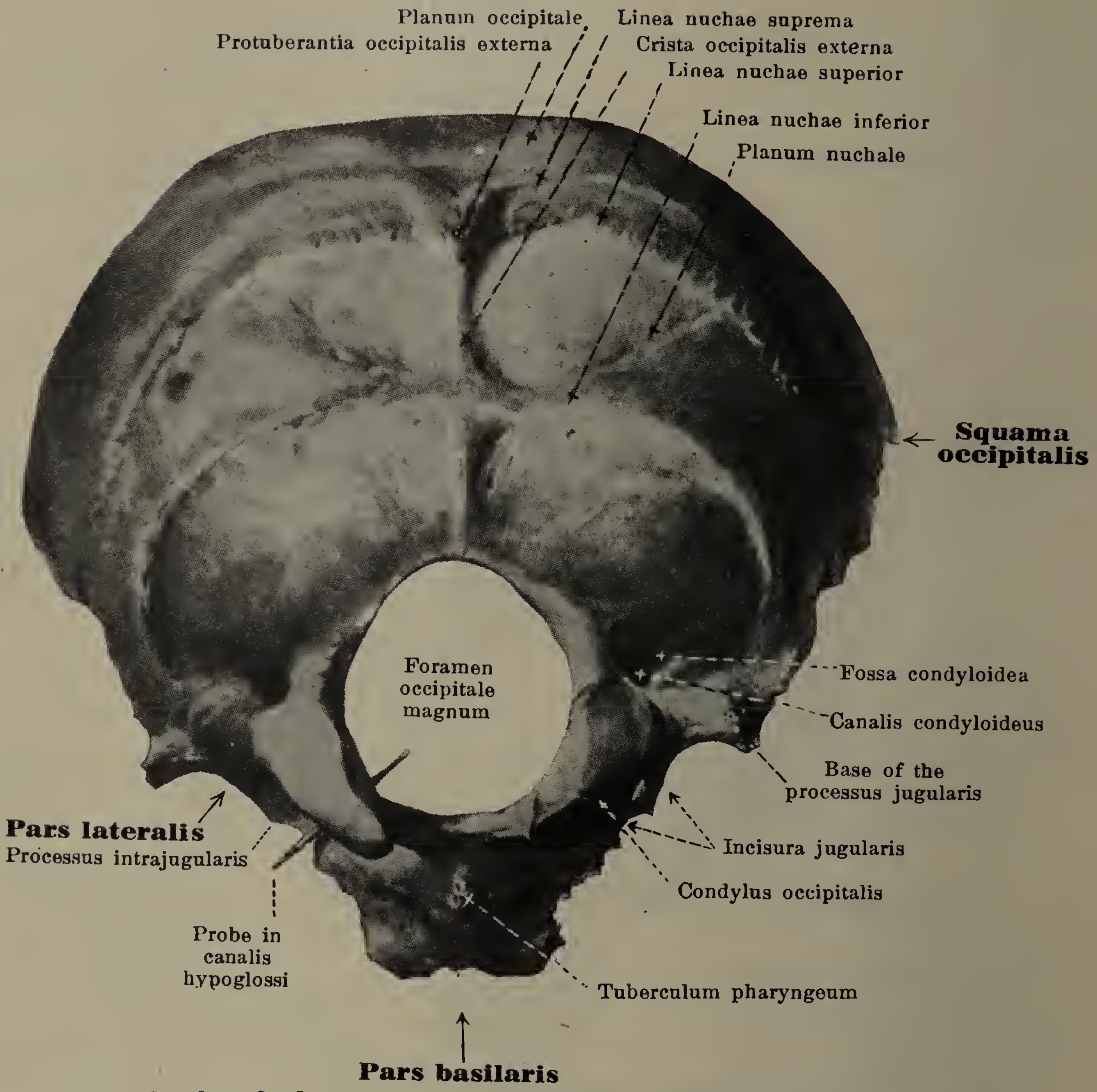
2. **Skeleton,** *sceleton,* viewed from the right.



3. Occipital bone,
os occipitale,
viewed from in front.

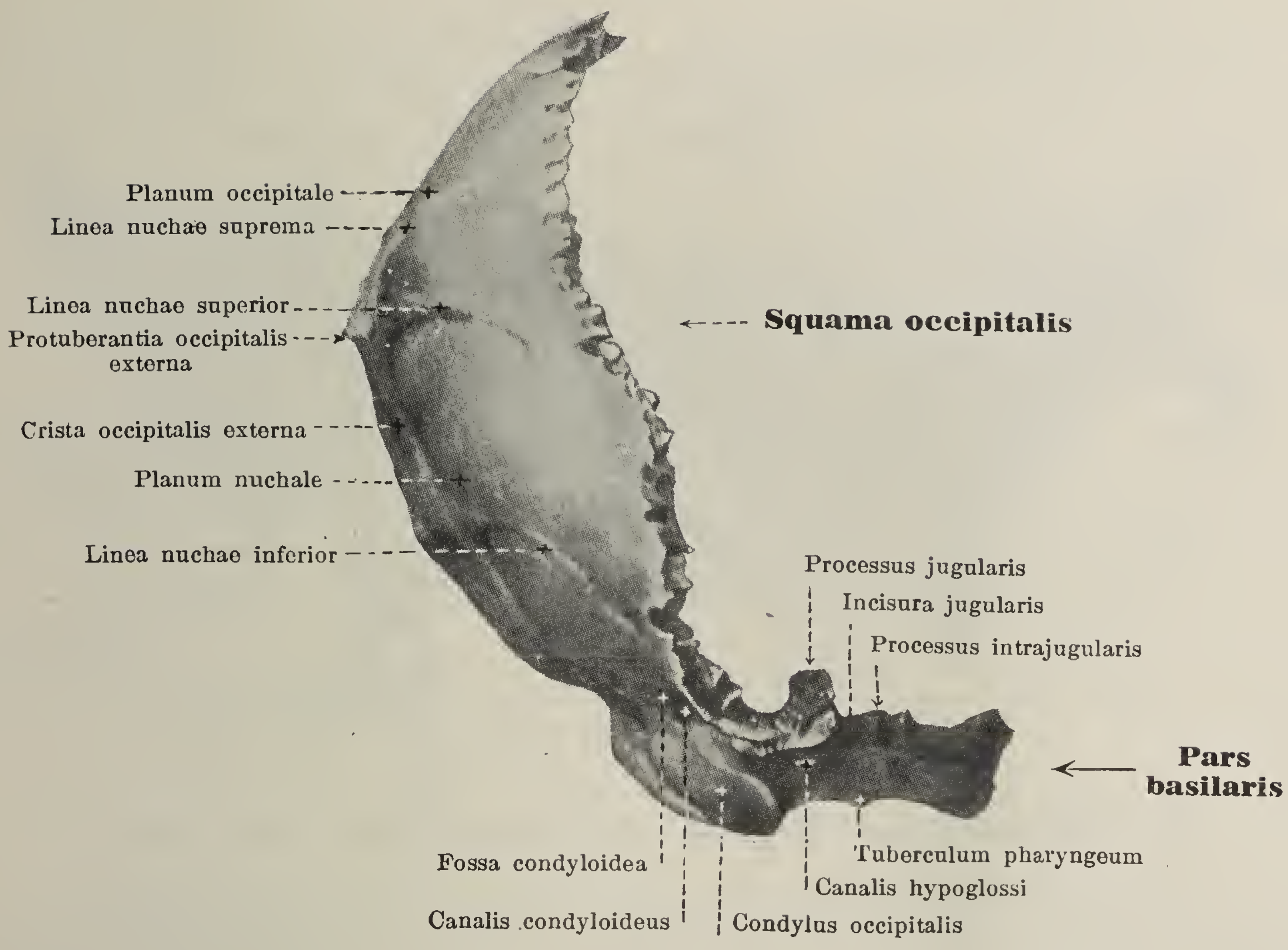
The unpaired **os occipitale** *(occipital bone)* (see also Figs. 4, 5, 57, 58 and 61—68) forms the posterior inferior part of the skull. It is divisible into four parts (see also p. 67): an unpaired basilar part *(pars basilaris)*, an unpaired squama-occipital part *(squama occipitalis)* and the paired lateral parts *(partes laterales)*. These parts are so arranged around the oblong *large occipital foramen (foramen occipitale magnum)* that the pars basilaris lies in front of the foramen, the squama occipitalis behind and above it, while the partes laterales lie lateral from it. Through the great occipital foramen pass the meningeal rami of the vertebral arteries, the vertebral arteries themselves, the anterior and posterior spinal arteries, the basilar plexus, the nn. accessorii, and the medulla oblongata. The border-line between pars basilaris and pars lateralis corresponds to the canalis hypoglossi; the border-line between pars lateralis and squama occipitalis extends from the posterior border of the foramen occipitale magnum transversely towards the middle of margo mastoideus. (Development see p. 67 a.)

The ***pars basilaris*** (see also Figs. 4, 5, 61, 62 and 65—68) presents, up to about the twentieth year of life, a rough surface in front corresponding to its attachment to the body of the sphenoid bone; the union is effected by a layer of hyaline cartilage which ossifies later *(fissura* and *synchodrosis sphenooccipitalis)*. The two lateral, slightly jagged edges lie upon of the posterior angle of the petrous portion of the temporal bone *(fissura* and *synchondrosis petrooccipitalis)*; on the upper surface along this edge is situated the groove, formed by the two bones in common, corresponding to the *sulcus petrosus inferior* (for the sinus petros. inf.). The posterior border, sharp in the middle, is smooth and concave, and forms the anterior circumference of the for. occip. mag.. The superior surface is smooth and slightly concave in a frontal direction; it helps to form the *clivus* (see p. 6) inasmuch as it is directly continous with the posterior surface of the dorsum sellae of the sphenoid. The clivus gives support to the pons, the vertebral arteries, the basilar artery and their branches. The inferior surface presents in the median line a small projection, the pharyngeal tubercle *(tuberculum pharyngeum)* (for the attachment of the lig. longitud. ant. and the m. constrictor pharyngis sup.), and also alternating ledges for the m. rectus capitis ant. and the m. longus capitis. To the pars basilaris belong also the frontal part of the condylus occipitalis and the tuberculum jugulare on each side (see p. 4).



4. Occipital bone, *os occipitale,* viewed from behind.

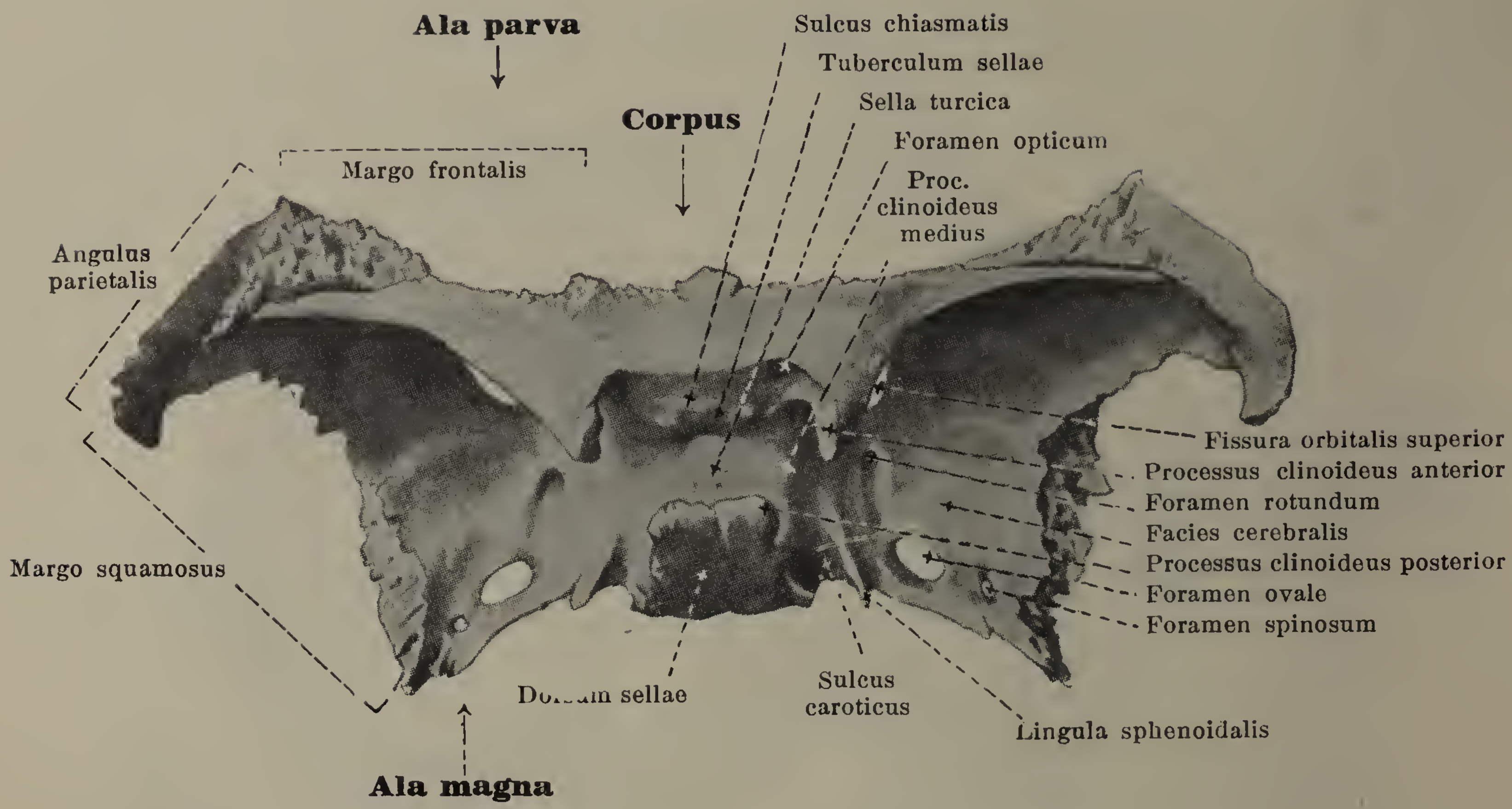
The ***partes lateralis*** (see also Figs. 3, 5, 61, 62 and 65—68) by their medial edges form the lateral borders of the great occipital foramen; the anterior portion of the lateral margin is attached to the posterior angle of the petrous portion of the temporal bone and helps to form the *fissura petrooccipitalis;* it presents a smooth concavity, the *incisura jugularis,* which is divided by the small *processus intrajugularis* into a larger lateral, posterior, and a smaller medial, anterior fossa, which, with the corresponding notches of the petrous portion of the temporal bone, help to form the similarly divided *foramen jugulare.* The lateral compartment of the jugular foramen gives passage to the internal jugular vein; the medial compartment to the sinus petrosus inf., the n. glossopharyngeus, n. vagus, n. accessorius, ganglion superius n. glossopharyngei and the ganglion jugulare n. vagi. The posterior part of the lateral border, *margo mastoideus,* is rough and unites with the occipital margin of the mastoid portion of the temporal bone *(sutura occipitomastoidea).* At the lateral angle between the two divisions of the lateral border, the *processus jugularis* projects upward, being surrounded medianward and behind by the *sulcus transversus* (for the sinus transversus). Median from this lies an oblong, smooth protuberance, *tuberculum jugulare,* and at the corresponding spot on the inferior surface the oval *occipital condyle (condylus occipitalis).* which is covered with cartilage; its anterior portion overlaps the pars basilaris; the condyle is curved so as to be convex in the sagittal and frontal direction. The long diameters of the right and left condyles converge in front. Between the jugular tubercle and the occipital condyle is seen the short and sometimes double *canalis hypoglossi* (O. T. anterior condyloid foramen); it extends from the great occipital foramen obliquely forward and lateralward and gives passage to the rete canal. hypogl. and the n. hypoglossus. Behind the condyle lies the *condyloid fossa (fossa condyloidea)* with an opening (sometimes absent) known as the *canalis condyloideus* (O. T. posterior condyloid foramen); this canal leads to the sulcus transversus and gives passage to the emissarium condyloideum. On the inferior surface corresponding to the base of the jugular process is the site of insertion of the m. rectus capit. lat. and sometimes a blunt projection, the *processus paramastoideus* (not shown in the figure).



5. Occipital bone, *os occipitale,* viewed from the right side.

(The direction does not correspond to that of the bone when the skull is in its ordinary position.)

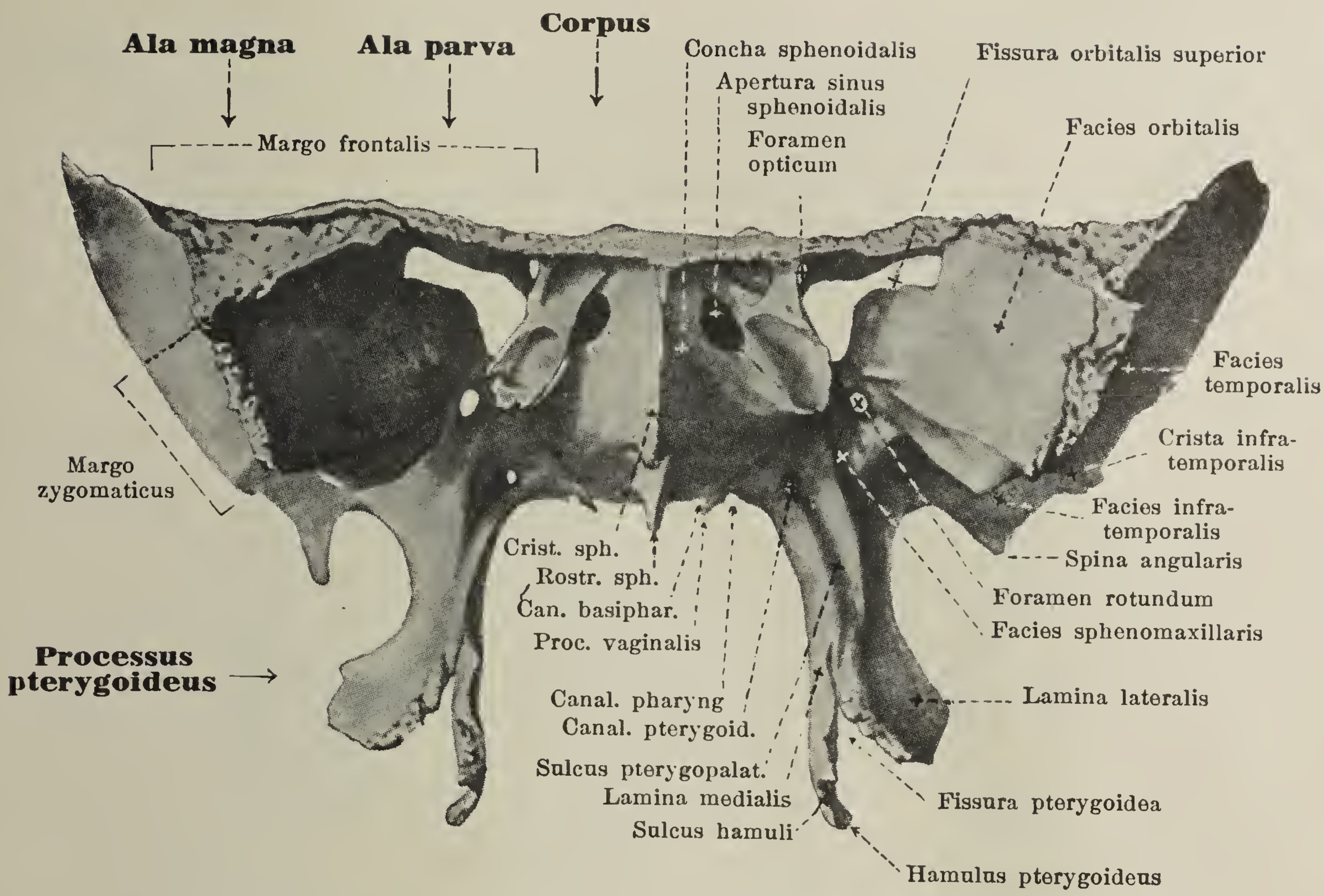
The ***squama occipitalis*** (see also Figs. 3, 4, 57, 58 and 61—68) is curved so as to be convex bachward in the sagittal and transverse direction. Its anterior border forms in the centre the posterior periphery of the foramen occipitale magnum; the free lateral and superior borders meet in the median plane, forming an obtuse angle, the lower portion of each lateral border being slightly serrated as the continuation of the *margo mastoideus* (p. 4); the upper portion of this border is deeply and multiply serrated and is known as the *margo lambdoideus* for union with the occipital margin of the parietal bone *(sutura lambdoidea).* Projecting from the middle of the posterior surface is seen the external occipital protuberance *(protuberantia occipitalis externa).* Extending lateralward from this protuberance on each side are the superior nuchal lines *(lineae nuchae superiores),* convex upward, and above these the less constant supreme nuchal lines *(lineae nuchae supremae).* In the median plane, extending toward the foramen magnum, is seen the external occipital crest *(crista occipitalis externa)* which gives attachment to the ligamentum nuchae. From about the middle of the crest extend lateralward the two inferior nuchal lines *(lineae nuchae inferiores),* also convex upward. The area for the m. occipitalis above the external protuberance and the supreme nuchal lines is called the occipital plain *(planum occipitale),* while that below the same is designated the nuchal plain *(planum nuchale)* and gives attachment to the mm. trapezius, sternocleidomastoideus, splenius capitis, semispinalis capitis, obliquus capitis superior, recti capitis posteriores. On the anterior surface of the bone at the middle point of the eminentia cruciata (approximately at the height of the protuberantia externa) is seen the internal occipital protuberance or *protuberantia occipitalis interna* (for the confluens sinuum; falx cerebri, and tentorium cerebelli). From the internal protuberance arise three well marked grooves: one in the median line passes upward, the *sulcus sagittalis* (O. T. superior longitudinal sulcus) for the sinus sagittalis superior and the falx cerebri: and one lateralward on each side, the *sulcus transversus* (for the sinus transversus; tentorium cerebelli) Of the two transverse sulci the right is usually wider than the left and it alone is continuous with the sulcus sagittalis. A fourth groove or (more often) ridge extends to the foramen magnum and receives the sinus occipitalis. The anterior surface presents variable marked ledges resembling cerebral sulci, *juga cerebralia* and *cerebellaria*, and furrows resembling cerebral windings, *impressiones digitatae.* The lower depressions help to form the posterior skull fossa.



6. Sphenoid bone, *os sphenoidale,* from above.

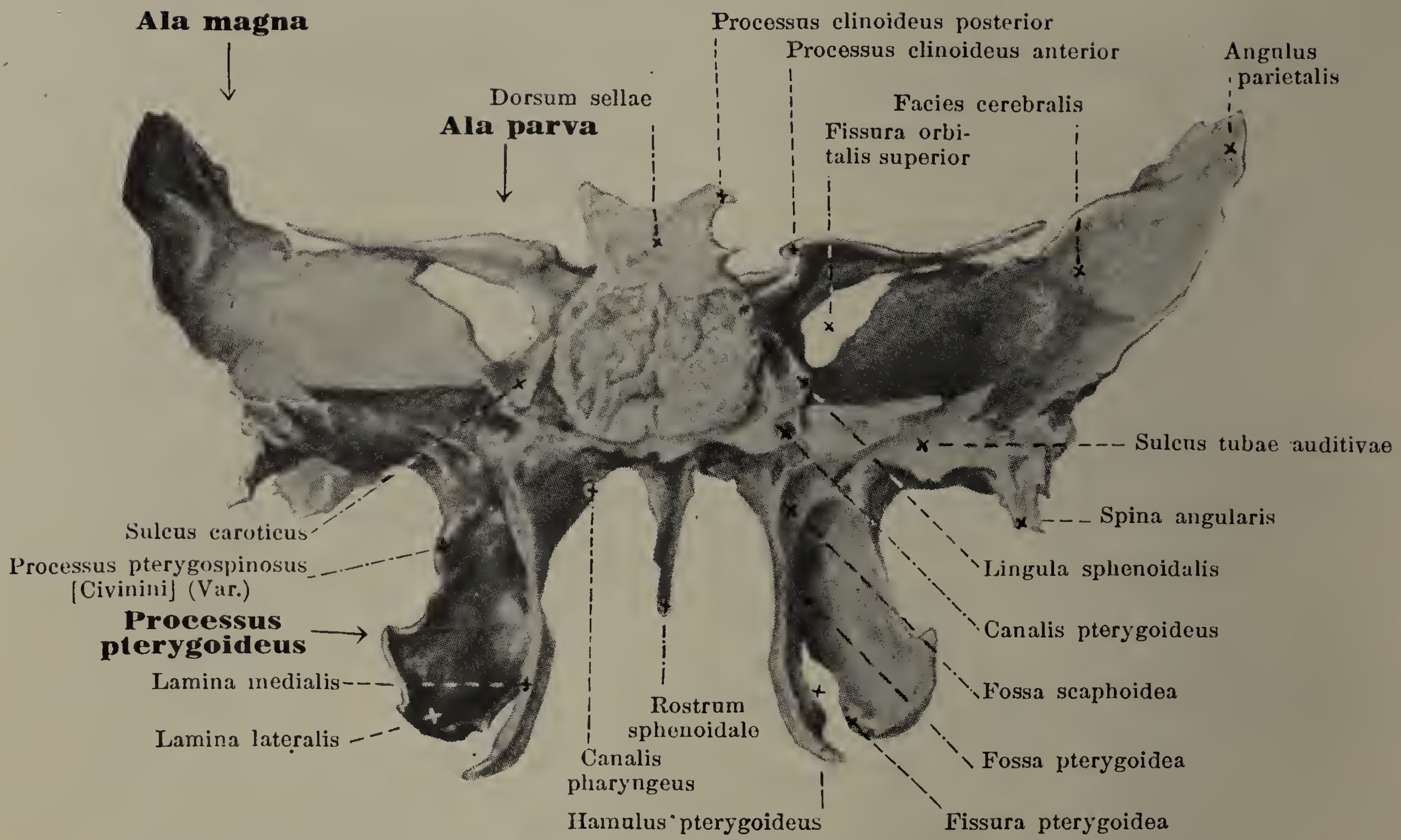
The unpaired **os sphenoidale** (see see also Figs. 7, 8, 57, 58, 61, 62, 65—73) lies in the middle of the base of the skull. It is divisible into a middle piece or body *(corpus)* and six processes, known as the two small wings or *alae parvae*, the two large wings or *alae magnae* and the two pterygoid processes or *processus pterygoidei;* of these the four former are directed lateralward, the two latter downward. (Development see p. 67 b.)

The ***corpus*** *(body)* (see also Figs. 7, 8, 61, 65—68, 70) is approximately cubical and contains within it two cavities lined by mucous membrane, of very variable size, the *sinus sphenoidales* (O. T. sphenoidal cells) which are separated from one another by the *septum sinuum sphenoidalium* often diverging from the median line. The superior surface presents a deep frontally placed groove, the *sella turcica* (for the sinus circularis; hypophysis), with the *fossa hypophyseos* (O. T. pituitary fossa) in the depth. Posteriorly, the sella is overhung by the *dorsum sellae*, which at the angles of its upper free margin presents on each side a small *processus clinoideus posterior* (for the tentorium cerebelli); the posterior smooth surface of the dorsum sellae, together with the superior surface of the pars basilaris oss. occipitalis, forms the *clivus*, on which lie the aa. vertebrales, the a. basilaris and its branches, and the pons. In front of the sella lies the small *tuberculum sellae* or pommel; lateralward and dorsally therefrom is situated the middle clinoid process or *processus clinoideus medius* (often absent). In front of the tubercle, extending transversely on each side to the foramen opticum, is the shallow *sulcus chiasmatis* (O. T. optic groove) behind which lies the chiasma opticum. The anterior margin of the superior surface unites with the lamina cribrosa of the ethmoid bone to form the *sutura sphenoethmoidalis*. On the lateral surface extending from behind forward, above the region of origin of the large wing is the *sulcus caroticus* (O. T. cavernous groove) for the a. carotis interna and the plexus caroticus internus. Just lateralward from the posterior extremity of this sulcus projects the *lingula sphenoidalis*. The posterior surface of the body unites with the pars basilaris oss. occipitalis (see p. 3). The anterior, and a part of the inferior, surface are formed by the thin, saucer-shaped, curved *conchae sphenoidales* (O. T. sphenoidal turbinated bones) which, embryologically, properly belong to the ethmoid bone, but which between the 9th—12th year of life grow together with the sphenoid bone. On forcible separation of the bones of the adult skull they usually adhere to the sphenoid bone and are therefore commonly described together with it. Each presents lateralward and above an opening, the *apertura sinus sphenoidalis* and, lateralward from this, small depressions which form the posterior walls of the posterior ethmoidal cells. The borders of these conchae (see Fig. 70) are connected with the labyrinthus oss. ethmoidal. (sutura sphenoethmoidalis); below they are in contact with the proc. orb. oss. palat. (sutura sphenoorbitalis. Fig. 70). In the median plane the conchae and the septum in front form the projecting sphenoidal crest or *crista sphenoidalis* (O. T. ethmoidal crest) for contact with the perpendicular plate of the ethmoid bone; this crest runs out below into a projection, the *rostrum sphenoidale*, which is directed downward and lies against the vomer.



7. Sphenoid bone, *os sphenoidale,* from in front.

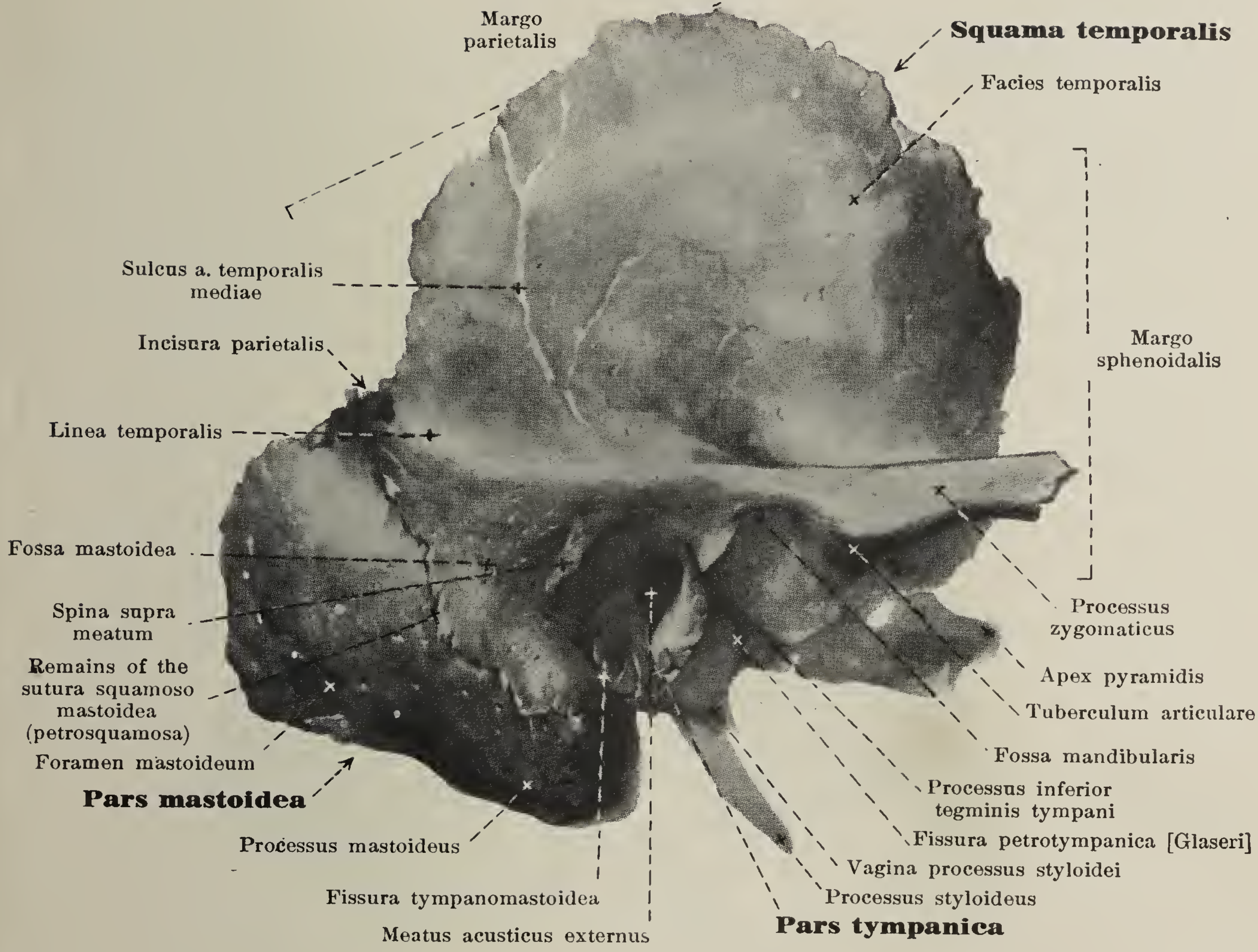
The ***alae magnae*** **ossis sphenoidalis** ***(large wings of the sphenoid bone)*** (see also Figs. 6, 8, 57, 58, 61, 62 and 65—73) arise from the lateral surface of the body of the bone and turn first lateralward, then upward and forward. Each possesses an upper, internal, concave surface or *facies cerebralis* with *juga cerebralia* and *impressiones digitatae* (see p. 5) (directed towards the medial skull fossa), and a much divided external surface. Of the latter, the quadrangular part which, medianward, is directed forward into the orbit, is called the orbital surface or *facies orbitalis;* its posterior border is smooth, curved and is separated from the ala parva by a fissure wider towards the median line and narrow laterally, the *fissura orbitalis superior* (for the vv. ophthalm. sup. et inf.; nn. oculomot., trochlearis, ophthalm., abducens); the inferior border, also smooth, runs nearly parallel with the posterior border of the facies orbitalis maxillae and is separated from it by a fissure spreading laterally, the *fissura orbitalis inferior* (for the a. infraorbital.; v. ophthalm. inf.; nn. zygomat., infraorbit., rami orbitales ganglii sphenopalatini); the lateral serrated border, *margo zygomaticus,* unites with the frontosphenoidal process of the zygomatic bone to form the *sutura sphenozygomatica;* the superior serrated border and its adjoining rough surface, a part of the *margo frontalis,* unites with the orbital portion of the frontal bone and thus helps to form the *sutura sphenofrontalis.* Below the orbital surface and encroaching upon the pterygoid process lies the triangular *facies sphenomaxillaris (sphenomaxillary surface)* which helps to form the fossa pterygopalatina. The rest of the external surface is divided by the *crista infratemporalis* (O. T. pterygoid ridge), passing from before backward, into an inferior, horizontal field or *facies infratemporalis* (for the m. pterygoid. ext.) which looks into the fossa infratemporalis, and a superior vertical field or *facies temporalis* (for the m. temporalis) which helps to form the fossa temporalis. The posterior border of the latter, *margo squamosus,* is serrated below, somewhat bevelled from without inward above, and serves for apposition with the squama temporalis *(sutura sphenosquamosa).* The uppermost angle *(angulus parietalis),* is bevelled from within and lies upon the angulus sphenoidalis oss. parietalis *(sutura sphenoparietalis).* Passing downward from the most posterior angle of the large wing is a small bony process, the *spina angularis* (O. T. spinous process of the sphenoid) (for the lig. sphenomandibulare; m. tensor veli palatini). In addition, there extends from this point forward and medianward, a short, serrated margin for apposition with the angulus anterior of the petrous portion of the temporal bone *(fissura* and *synchondrosis sphenopetrosa).* Perforating the root of the large wing are three foramina: passing forward from above and behind, to the sphenomaxillary surface is the *foramen rotundum* (for the n. maxillaris); passing downward, from above, to the infratemporal surface is the *foramen ovale* (for the rete foraminis ovalis; n. mandibul.); and the *foramen spinosum* (for the a. mening. med.; vv. meningeae mediae; n. spinosus, plexus mening.); the latter foramen lies just in front of the most posterior angle and is sometimes incomplete.



8. Sphenoid bone, *os sphenoidale,* from behind.

The ***alae parvae*** **ossis sphenoidalis** *(small wings of the sphenoid bone)* (see also Figs. 6, 7, 65, 68, 71 and 72) arise from the anterior superior part of the lateral surface of the body by two roots which surround the *foramen opticum* (for the a. ophthalmica; n. opticus). They are smooth thin plates of bone which present a superior and an inferior surface. The upper surface is smooth, and helps to form the anterior skull fossa, the inferior encompasses with the orbital surface of the large wing (cf. p. 7) the *fissura orbitalis superior.* The anterior margin, a part of the *margo frontalis,* is serrated and lies upon the posterior margin of the pars orbitalis oss. frontalis *(sutura sphenofrontalis);* the posterior margin is smooth, concave and runs out medianward and backward into the strong *processus clinoideus anterior;* this may be connected with the proc. clinoideus medius by a bony lamella, which transforms the first part of the sulcus caroticus into a *foramen clinoideocaroticum* (not shown in the figure).

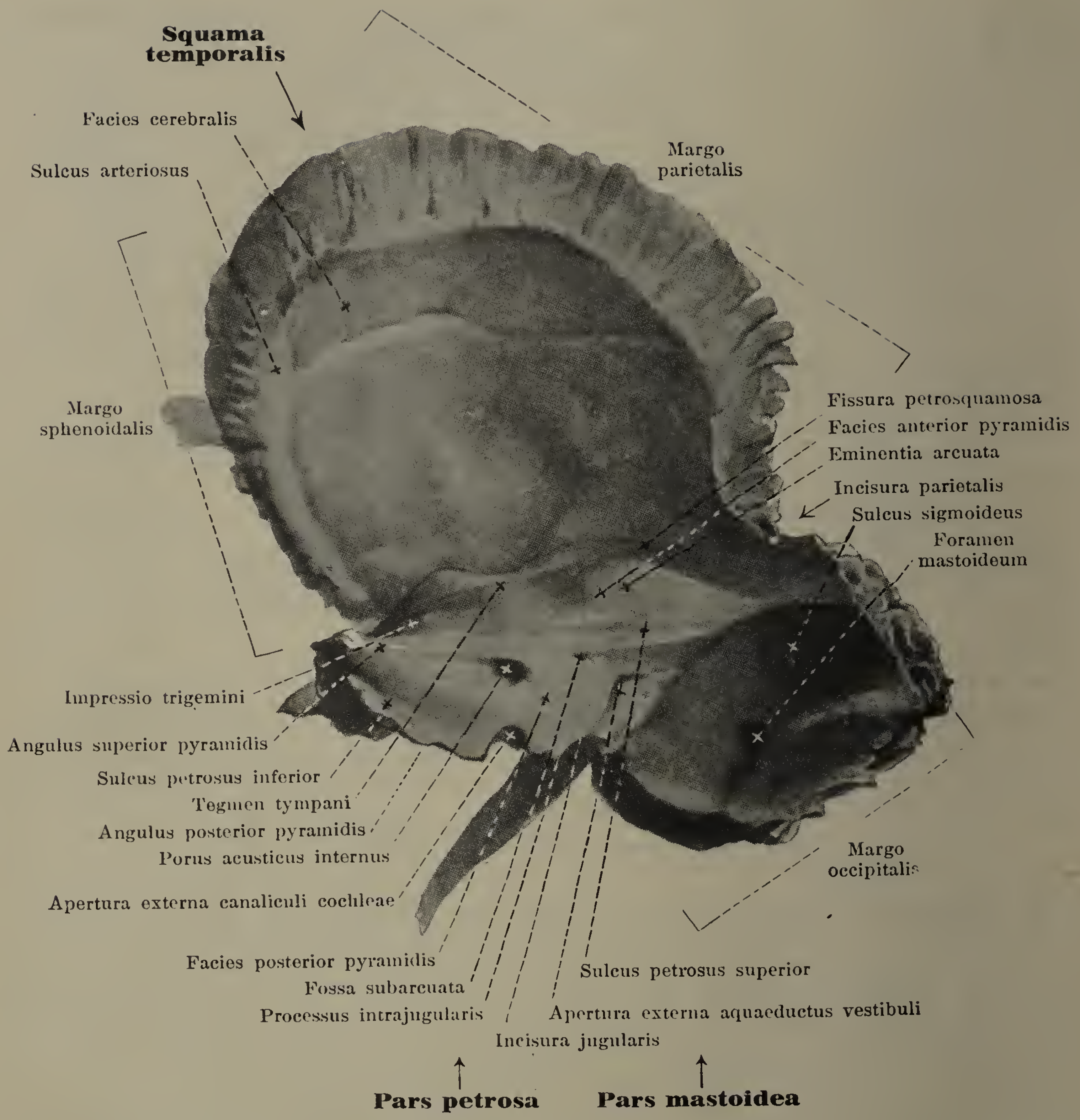
The ***processus pterygoidei*** *(pterygoid processes)* (see also Figs. 7, 61, 62 and 67—70) extend from the point of union of the body and the large wing downward. They are composed of two plates: the shorter and broader, *lamina lateralis proc. pteryg.* (lateral surface for the m. pterygoideus externus); the other narrower and longer, *lamina medialis proc. pteryg.*. The two plates unite anteriorly at an angle, in front of which there extends from above downward the *sulcus pterygopalatinus:* behind, the plates diverge and form the deep *fossa pterygoidea* (for the m. pterygoideus internus); between the two below is a notch with jagged borders, the *fissura pterygoidea,* in which is received the proc. pyramidalis oss. palatini, and over which the proc. pterygoideus sometimes lies against the facies infratemporalis maxillae (see Fig. 69). The lamina medialis runs out below to form the *hamulus pterygoideus* (O. T. hamular process) which is curved lateralward. This process is concave on its lateral surface and is covered with cartilage forming the *sulcus hamuli pterygoidei* (for the tendon of the m. tensor veli palatini). Passing downward over the root of the lamina medialis on the posterior surface is the *fossa scaphoidea* (for the origin of the m. tensor veli palatini). Lateralward and somewhat behind this fossa, encroaching upon the medial surface of the spina angularis lies the *sulcus tubae auditivae* (for the pars cartilaginea tubae auditivae). The lamina medialis gives off from its root the *processus vaginalis,* a small process which extends medianward toward the body; on the inferior surface of this process, either as a closed canal or as a groove which is closed by the proc. sphenoidalis oss. palatini, is the *canalis pharyngeus* (O. T. pterygopalatine canal) (for a small branch of the a. sphenopalatina; rr. nasal. post. sup. lat. gangl. sphenopalat.); between the inferior surface of the body of the bone and the processus vaginalis, a canal is sometimes present, the *canalis basipharyngeus* (for the rr. nasal. post. sup. lat. gangl. sphenopalat.). Constantly present, passing through the root of the pterygoid process in a sagittal direction, is the *canalis pterygoideus [Vidii]* (O. T. Vidian canal) (for the a. et vv. canal. pteryg.; n. canal. pteryg.); its posterior opening lies below the lingula sphenoidalis, its anterior opening upon the sphenomaxillary surface, medianward and below the foramen rotundum.



9. Right temporal bone, *os temporale,* from without.

The paired **os temporale** or temporal bone (see also Figs. 10—17, 57, 58, 61, 62 and 65—67) lies between the occipital bone and sphenoid bone, helping to form both the base of the skull and its lateral wall. Each bone is divisible in the adult into four parts; the *squama temporalis, pars mastoidea, pars petrosa* and *pars tympanica.* Around the *meatus acusticus externus (external auditory canal),* which opens lateralward through the oval *porus acusticus externus,* these parts are so arranged that the squama is directed upward, the pars mastoidea backward, the pars tympanica forward and downward and the pars petrosa medianward and forward. (For the development see p. 68.)

The ***squama temporalis*** (see also Figs. 10—12, 14, 17, 57, 58, 61, 62 and 65—68) consists essentially of a vertical plate, the free approximately semi-circular border of which is serrated only in its anterior inferior portion, being otherwise bevelled from within; the anterior part of the margin, *margo sphenoidalis,* unites with the large wing of the sphenoid bone to form the *sutura sphenosquamosa,* the posterior, *margo parietalis,* with the margo squamosus oss. parietalis to form the *sutura squamosa.* The lateral surface, *facies temporalis* (for the m. temporalis), is smooth; projecting from the lower part of this surface in front of the external auditory canal is the *processus zygomaticus* (for the lig. temporomandibulare; m. masseter) with two roots of origin; it passes at first horizontally outward, then straight forward (see also Figs. 11 and 12): it is serrated anteriorly and joins the proc. temporalis ossis zygomatici. Between the two roots, directed downward and covered with cartilage in front, lies the *fossa mandibularis* (O. T. glenoid cavity) with the *facies articularis* limited in front by the frontally placed *tuberculum articulare,* the latter being covered by fibrocartilage. On the outer surface of the squama temporalis is seen, passing upward in the posterior part, the *sulcus arteriae temporalis mediae* (for the a. tempor. med.). Running out also from the posterior extremity of the zygomatic process is a ridge, the *linea temporalis,* which curves backward to become continuous with the linea temporalis inferior of the parietal bone. The medial surface of the squama, *facies cerebralis* (see Fig. 10), directed towards the median skull fossa, presents well marked juga cerebralia and impressiones digitatae (see p. 5) as well as a deep *sulcus arteriosus;* besides the thin spot corresponding to the fossa mandibularis often presents a bulbous projection.



10. Right temporal bone, ***os temporale,*** from within and above.

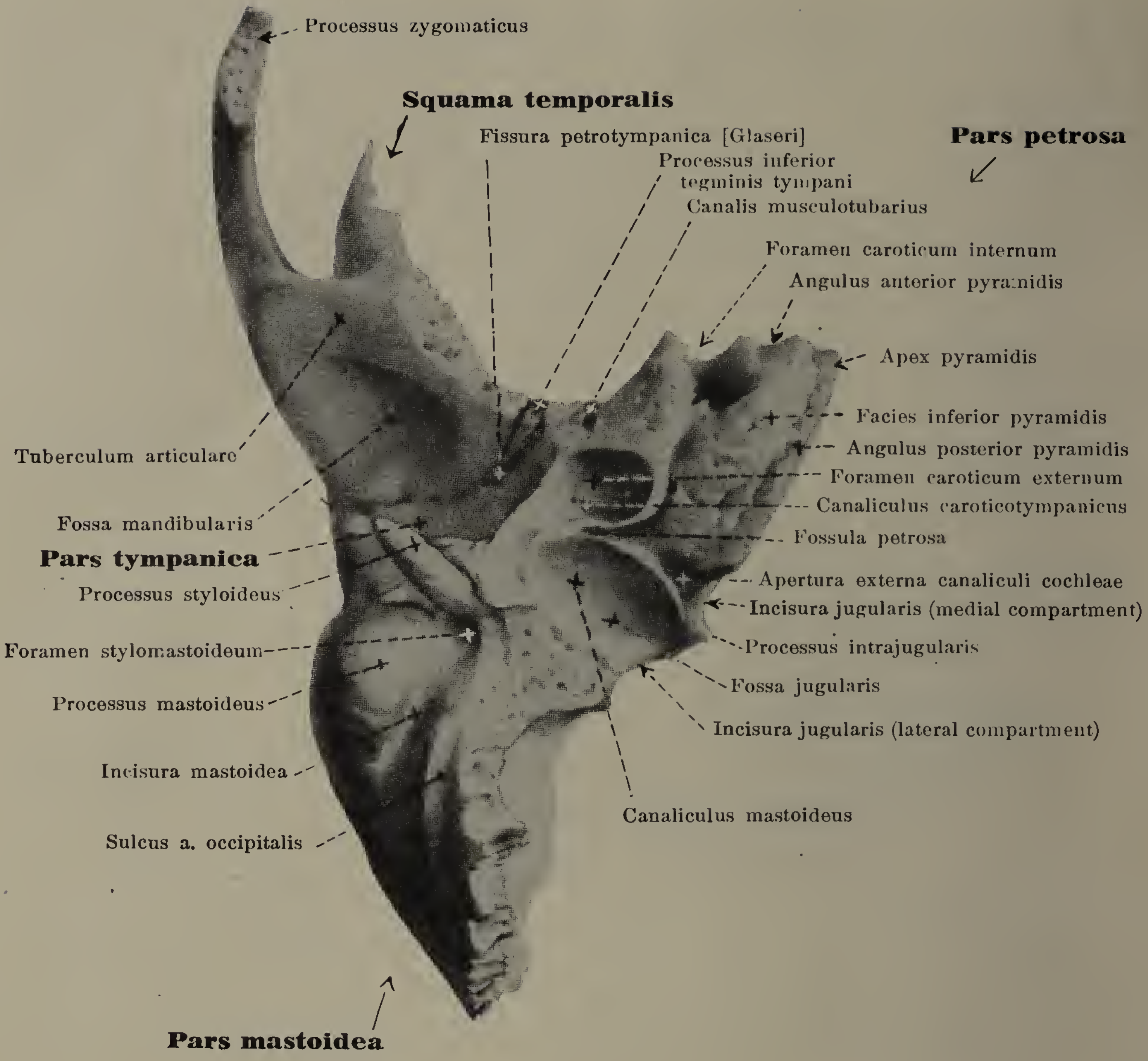
The ***pars mastoidea*** (see also Figs. 9, 11—17, 57, 58, 61, 62 and 65—68) is a thick conical projection not well developed until adult life. It does not develop as an independent part of the bone, but as a secondary outgrowth from the lateral and most posterior part of the temporal bone; its anterior portion is formed from the squama temporalis (see p. 69), its posterior portion from the pars petrosa (see Figs. 14—16). The site of junction of its two components is in a third of cases in adults a suture on the lateral surface directed from the incisura parietalis towards the point of the proc. mastoideus (falsely termed *sutura squamosomastoidea*, and more correctly to be named *sutura petrosquamosa).* Its posterior, serrated margin, *margo occipitalis*, comes into apposition with the margo mastoideus oss. occipitalis *(sutura occipitomastoidea)*: the short upper serrated margin forms with the margo parietalis of the squama temporalis an angular indentation, the *incisura parietalis*, in which is received the angulus mastoideus oss. parietalis *(sutura parietomastoidea);* above and in front it goes over into the squama temporalis, in front it adjoins the pars tympanica. The lateral surface is convex and slightly roughened (for the attachment of the mm. auricularis posterior et occipitalis), and often presents behind one or several *foramina mastoidea* (for the ramus mastoideus a. occipitalis; emissarium mastoideum) which open on the medial surface in the sulcus sigmoideus. Projecting lateralward from the posterior superior margin of the porus acusticus externus there is frequently found a small spur, the *spina supra meatum:* the surface behind it, often depressed, the *fossa mastoidea*, extends above as far as the linea temporalis and is perforated by numerous foramina for blood vessels.

A thick process extending downward, the *processus mastoideus* (for the attachment of the mm. sternocleidomastoideus, splenius capitis, longissimus capitis) (see Figs. 9, 11 and 61) presents on its medial surface a smooth depression, the *incisura mastoidea* (O. T. digastric fossa) for the attachment of the digastric muscle, and further medianward, a groove, the *sulcus arteriae occipitalis* (for the a. occipitalis). The medial surface of the pars mastoidea (see Figs. 10 and 11) is fused in front with the pars petrosa; behind, it is free and there presents a deep groove, curving from above and behind downwards and forwards, the *sulcus sigmoideus* (O. T. fossa sigmoidea) (for the sinus transversus). Inside the process are many cavities lined by mucous membrane, the *cellulae mastoideae* (see Fig. 13), very variable in their development.

The ***pars petrosa (pyramis)*** (see Figs. 9—13, 61, 62, 65—68) is a three-sided oblique pyramid, the base of which is directed lateralward, and is united with the pars mastoidea. It completely encloses the internal ear, and together with the squama temporalis and the pars tympanica, the middle ear. It presents for examination three surfaces, a *facies posterior*, a *facies inferior* and a *facies anterior;* at the junctions of the surfaces are the *angulus posterior*, the *angulus anterior* and the *angulus superior.* The tip, or *apex pyramidis*, is directed medianward and forward, and is inserted in the angle between the occipital bone and the sphenoid bone. Between the anterior border and the sphenoid bone is an irregular chink, the *foramen lacerum;* it is filled with a mass of connective tissue, the *fibrocartilago basalis*, which is scooped out on its upper surface into a groove containing the a. carotis interna, the plexus venosus caroticus internus, and the plexus (sympathicus) caroticus internus, and is pierced by the nn. petrosi superficiales.

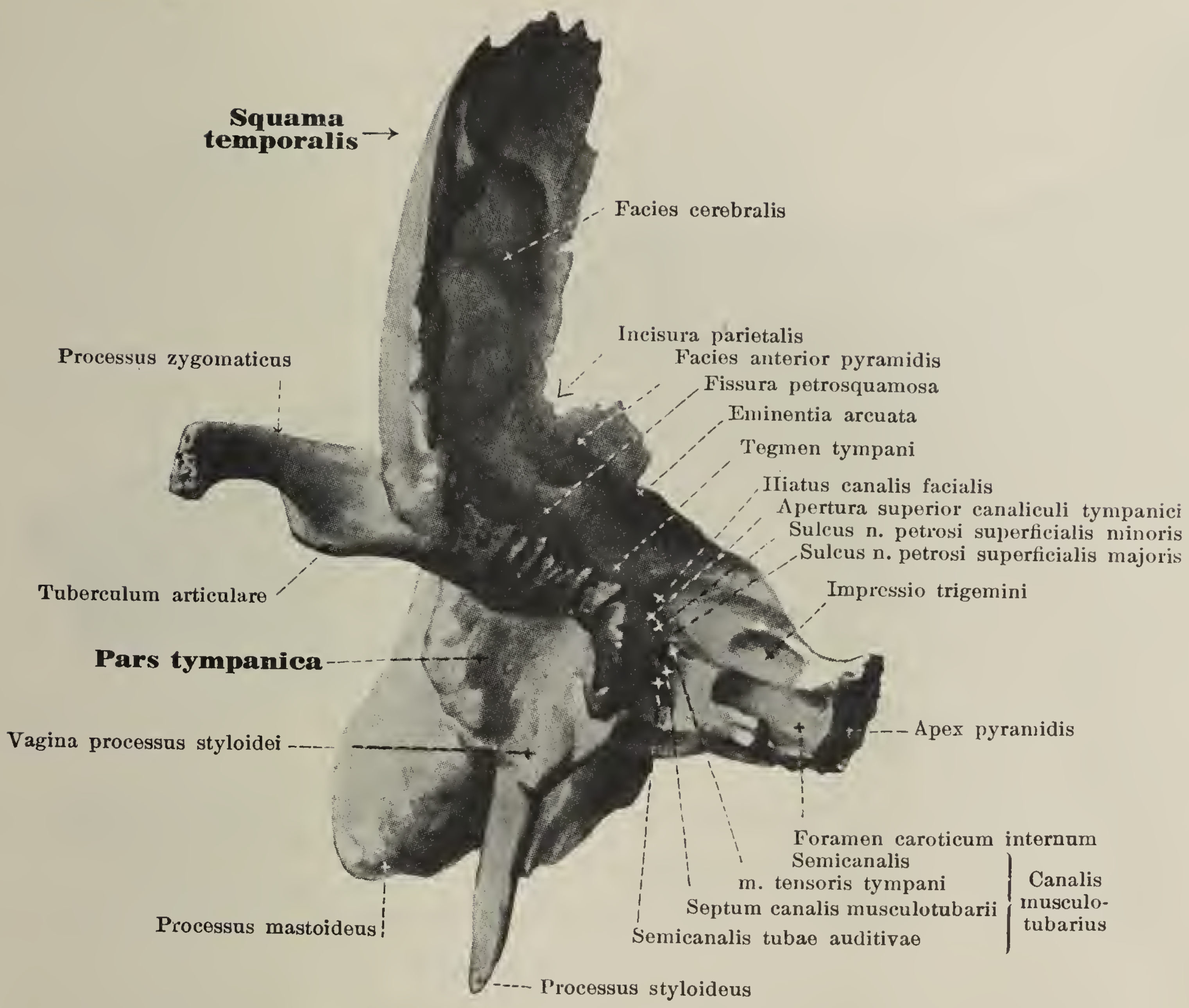
The ***facies posterior pyramidis*** almost vertical and directed towards the posterior skull fossa, is bounded above by the *angulus superior* with the *sulcus petrosus superior* (for the sinus petrosus superior; tentorium cerebelli), below by the *angulus posterior;* the latter is rough and unites with the lateral margin of the pars basilaris and the pars lateralis of the occipital bone *(fissura* and *synchondrosis petrooccipitalis)*, and contains above at the upper surface of this place of union the *sulcus petrosus inferior* (for the sinus petrosus inferior). At about the middle of the posterior surface a circular opening, the *porus acusticus internus*, leads transversely and frontally into the short *meatus acusticus internus* (for the a. and vv. auditivae internae; nn. facialis and acusticus) (see p. 850). Above lateralward and upwards, close to the superior angle lies the *fossa subarcuata* which, running below the superior semicircular canal, receives a process of the dura mater; this fossa, very well marked in the new-born (see Fig. 15), is usually only slightly indicated in the adult. Still further lateralward and downward is seen the *apertura externa aquaeductus vestibuli* (for the ductus endolymphaticus); it is usually a slit-shaped opening from a dorsolateral direction, and from it a groove runs downward to the incisura jugularis.

The ***facies inferior pyramidis*** (see Fig. 11) is placed horizontally and is very uneven and rough. In front its boundary is formed laterally by the pars tympanica and medianward therefrom by a free margin, the *angulus anterior*, which unites with the margin of the large wing of the sphenoid bone situated medianward from the spina angularis, to form the *fissura* and *synchondrosis sphenopetrosa.* Behind it is bounded by the *angulus posterior.* A notch, sometimes scarcely noticeable, the *incisura jugularis,* close to the small *processus intrajugularis* forms with the corresponding incisura jugularis of the occipital bone (p. 4) the *foramen jugulare* (lateral compartment for the v. jugularis interna; medial compartment for the sinus petrosus inferior; nn. glossopharyngeus, vagus, accessorius, gangl. superius n. glossopharyngei, gangl. jugulare n. vagi). Just in front of the lateral compartment of this notch lies the broad *fossa jugularis* (for the bulbus v. jugularis superior) with a small hole, one of the openings of the *canaliculus mastoideus*, and a groove leading to this, the *sulcus canaliculi mastoidei* (for the r. auricularis n. vagi). Just medianward from the jugular fossa, near the medial compartment of the incisura jugularis, is seen a triangular funnel-shaped depression, with the *apertura externa canaliculi cochleae* (for the v. canaliculi cochleae; ductus perilymphaticus) deep down.


Processus zygomaticus
Squama temporalis
Fissura petrotympanica [Glaseri]
Processus inferior tegminis tympani
Canalis musculotubarius
Pars petrosa
Foramen caroticum internum
Angulus anterior pyramidis
Apex pyramidis
Facies inferior pyramidis
Angulus posterior pyramidis
Foramen caroticum externum
Canaliculus caroticotympanicus
Fossula petrosa
Apertura externa canaliculi cochleae
Incisura jugularis (medial compartment)
Processus intrajugularis
Fossa jugularis
Incisura jugularis (lateral compartment)
Canaliculus mastoideus
Tuberculum articulare
Fossa mandibularis
Pars tympanica
Processus styloideus
Foramen stylomastoideum
Processus mastoideus
Incisura mastoidea
Sulcus a. occipitalis
Pars mastoidea

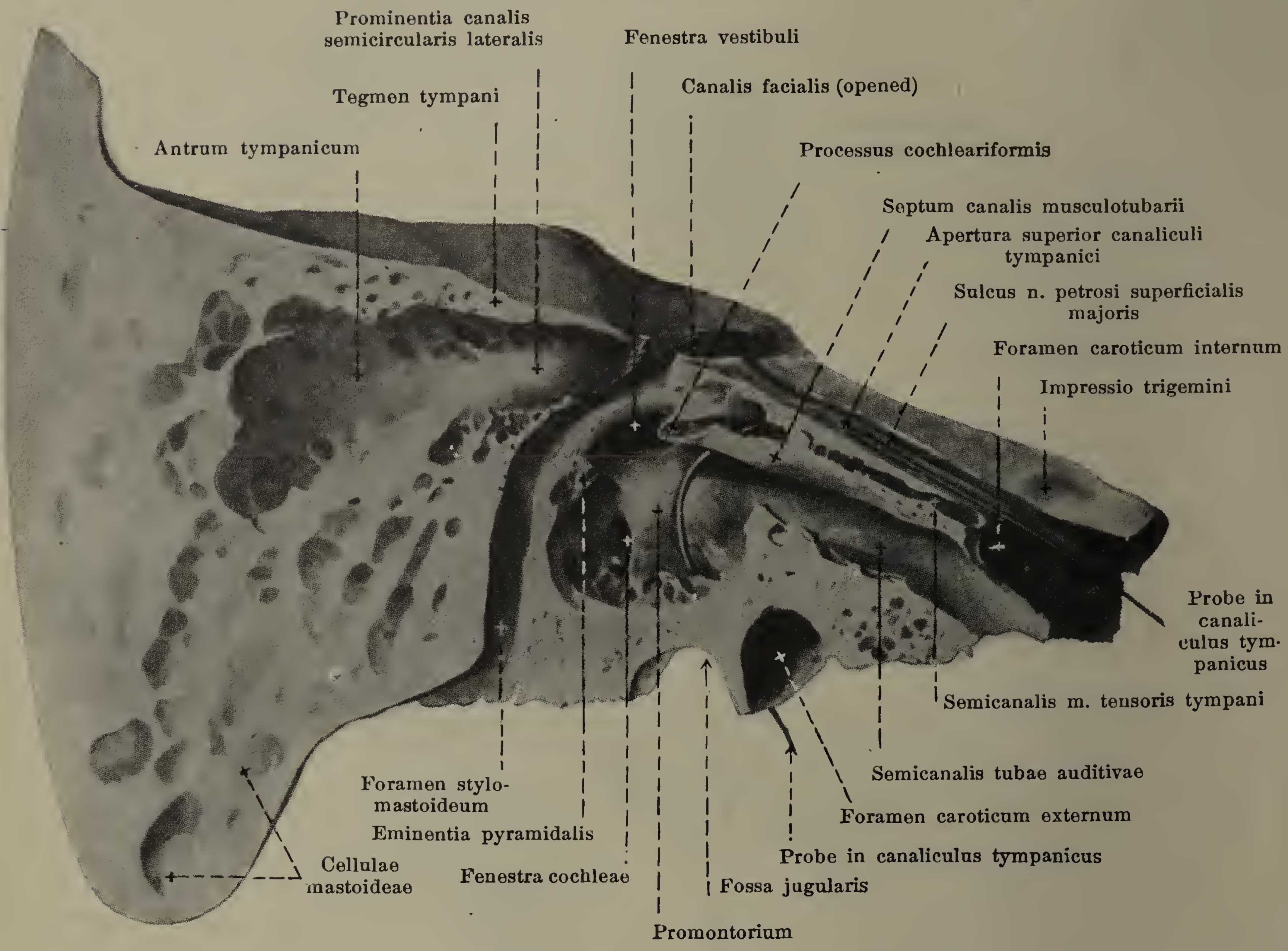
11. Right temporal bone, ***os temporale,*** from below.

Facies inferior pyramidis (continued). Situated almost exactly in front of the fossa jugularis is a large round opening, the *foramen caroticum externum*, which forms the entrance to the *canalis caroticus* (for the a. carotis interna; plexus venosus caroticus internus; plexus caroticus internus). This canal is curved and passes first perpendicularly, then transversely and obliquely from behind and lateralward, forward and medianward through the pyramid, and emerges near the apex by an irregular opening, the *foramen caroticum internum*, partly on the inferior and partly on the anterior surface. Near the external carotid foramen can be seen, in the canal, the small openings of the *canaliculi caroticotympanici* (for the r. caroticotympanicus a. carotis internae; nn. caroticotympanici), which pass upward to the middle ear. Between the external carotid foramen, the jugular fossa and the apertura externa canaliculi cochleae lies a small depression, the *fossula petrosa* (for the gangl. petrosum n. glossopharyngei) with a small opening, the *apertura inferior canaliculi tympanici* (for the a. tympanica inferior; n. tympanicus). Situated lateralward and projecting downward and forward is the *processus styloideus* (for the lig. stylomandibulare; mm. stylohyoideus, styloglossus, stylopharyngeus), variously developed in different individuals. Just behind it lies the *foramen stylomastoideum* (for the a. and v. stylomastoidea; n. facialis). Closely attached to the styloid process in front is seen the *vagina processus styloidei* (O. T. vaginal process), the lowest portion of the pars tympanica.


Squama temporalis
Facies cerebralis
Incisura parietalis
Facies anterior pyramidis
Fissura petrosquamosa
Eminentia arcuata
Tegmen tympani
Hiatus canalis facialis
Apertura superior canaliculi tympanici
Sulcus n. petrosi superficialis minoris
Sulcus n. petrosi superficialis majoris
Impressio trigemini
Apex pyramidis
Foramen caroticum internum
Semicanalis m. tensoris tympani
Septum canalis musculotubarii
Semicanalis tubae auditivae
Canalis musculotubarius
Processus styloideus
Processus mastoideus
Vagina processus styloidei
Pars tympanica
Tuberculum articulare
Processus zygomaticus

12. Right temporal bone, *os temporale,* from in front.

The ***facies anterior pyramidis*** (see also Figs. 10, 13, 65 and 66) is smooth, faces towards the median skull fossa and stands obliquely from behind and above, forward and downward. Laterally it is fused with the squama temporalis through the *fissura petrosquamosa,* where it goes over gradually into the cerebral surface of the squama. The free, rough, anterior margin is the *angulus anterior;* it forms an angle with the margo sphenoidalis of the squama in which fits the posterior angle of the large wing of the sphenoid bone. In this angle lies the opening of the *canalis musculotubarius,* directed forward and medianward ; this canal is divided, usually incompletely, by means of a leaflet of bone, projecting from its medial wall, the *septum canalis musculotubarii,* into a smaller upper and median part, the *semicanalis m. tensoris tympani* (O. T. canal for tensor tympani muscle) and a larger inferior part, the *semicanalis tubae auditivae* (O. T. canal for the Eustachian tube) (see also Fig. 968). The anterior surface is bounded behind by the *angulus superior* (p. 11). Projecting at a point somewhat lateralward from the middle of the anterior surface, near the posterior angle, is the *eminentia arcuata* (O. T. eminence for superior semicircular canal) mostly caused by the canalis semicircularis superior. The smooth region a little lateral from and in front of this, and continuing to the fissura petrosquamosa, is called the *tegmen tympani* since it covers the cavum tympani above. Still further forward two openings can be seen and two grooves running forward from them ; the medial opening, *hiatus canalis facialis* (O. T. hiatus Fallopii), leads through a short canal to the geniculum canalis facialis and contains the r. petrosus superficialis a. mening. med. and the n. petrosus superfic. maj., the latter passing further forward in the medial groove called the *sulcus n. petrosi superficialis majoris;* the lateral, smaller opening, sometimes fused with the medial, is known as the *apertura superior canaliculi tympanici* (O. T. opening for smaller petrosal nerve) through which run the a. tympanica superior and the n. petrosus superfic. min. in order to pass further on in the smaller, lateral groove, the *sulcus n. petrosi superficialis minoris.* On the upper surface near the apex of the pyramid lies the *impressio trigemini* (O. T. depression for Gasserian ganglion) for the n. trigeminus. In addition the facies anterior presents shallow *juga cerebralia* and *impressiones digitatae* (see p. 5).

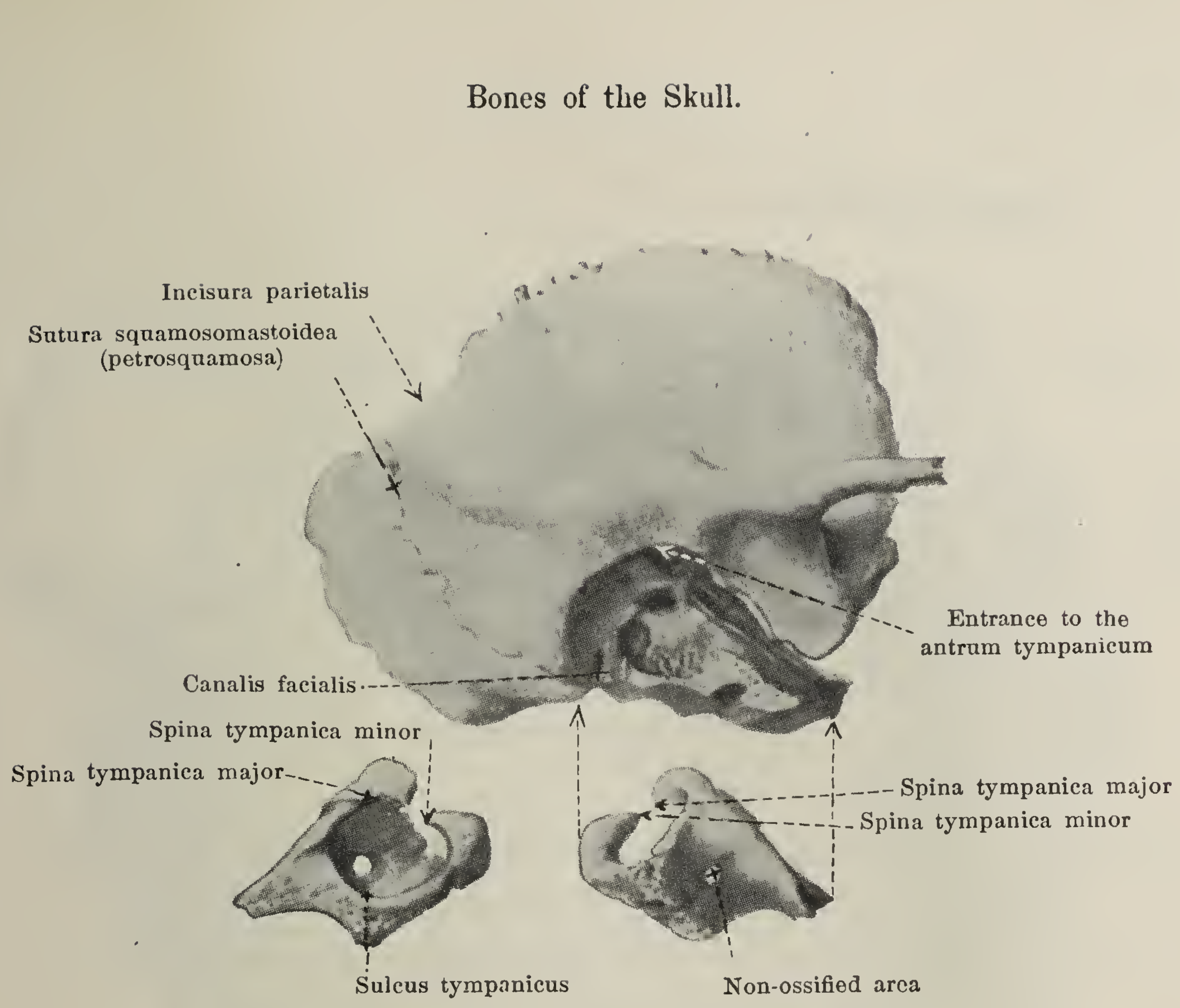

Prominentia canalis semicircularis lateralis
Fenestra vestibuli
Canalis facialis (opened)
Tegmen tympani
Antrum tympanicum
Processus cochleariformis
Septum canalis musculotubarii
Apertura superior canaliculi tympanici
Sulcus n. petrosi superficialis majoris
Foramen caroticum internum
Impressio trigemini
Probe in canaliculus tympanicus
Semicanalis m. tensoris tympani
Semicanalis tubae auditivae
Foramen caroticum externum
Probe in canaliculus tympanicus
Fossa jugularis
Promontorium
Fenestra cochleae
Eminentia pyramidalis
Foramen stylomastoideum
Cellulae mastoideae

13. Right temporal bone, ***os temporale,*** cut open, lateral view of medial half bone. Magnification: 2 : 1. (See also Fig. 946.)

(The canalis facialis is opened in its entire length).

The ***canalis facialis (Fallopii)*** (O. T. aqueduct of Fallopius) (for the a. and v. stylomastoidea, r. petrosus superficialis a. meningeae mediae; n. facialis, n. intermedius) begins in the floor of the meatus acusticus internus near the posterior surface of the pyramid (see p. 850), thence passes horizontally lateralward, after a short course bends around at a right angle, forming the *geniculum canalis facialis,* and from this point passes horizontally backward and lateralward and then downward. In doing so it lies close to the mastoid wall of the cavity of the tympanum and there forms the *prominentia canalis facialis* (see Figs. 951, 961, 965 and 966). It runs at first close beneath the facies anterior pyramidis, then between the fenestra vestibuli and the prominentia canalis semicircularis lateralis, then behind the eminentia pyramidalis to terminate in the *foramen stylomastoidum.* From the geniculum canalis facialis which, in the new-born (Fig. 17) lies free upon the anterior surface of the pyramid, a short canal passes medianward and forward to the *hiatus canalis facialis* (O. T. hiatus Fallopii) (for the r. petrosus superfic. a. mening. med.; n. petrosus superficialis major); another very delicate canal runs to the upper part of the canaliculus tympanicus (for the ramus anastom. cum plexu tympanico); behind the eminentia pyramidalis a little lateral branch is given off to enter this eminence (for the n. stapedicus) and below it arises the *canaliculus chordae tympani* (see Fig. 946), which leads into the middle ear, and receives the canalicus mastoideus for the ramus auricularis n. vagi (s. p. 15).

The *canaliculus tympanicus* (below for the a. tympanica inferior, above for the a. tympanica superior; besides for the n. tympanicus and n. petrosus superficialis minor) begins with an *apertura inferior* in the depth of the *fossula petrosa,* arrives in the cavum tympani on its inferior wall, runs over the promontorium in the *sulcus promontorii,* perforates the root of the processus cochleariformis and then passes in a curved direction in the bone, forward and upward to the *apertura superior canaliculi tympanici* on the anterior surface of the pyramid; in this upper part it receives a delicate canal coming from the geniculum canalis facialis (see above).



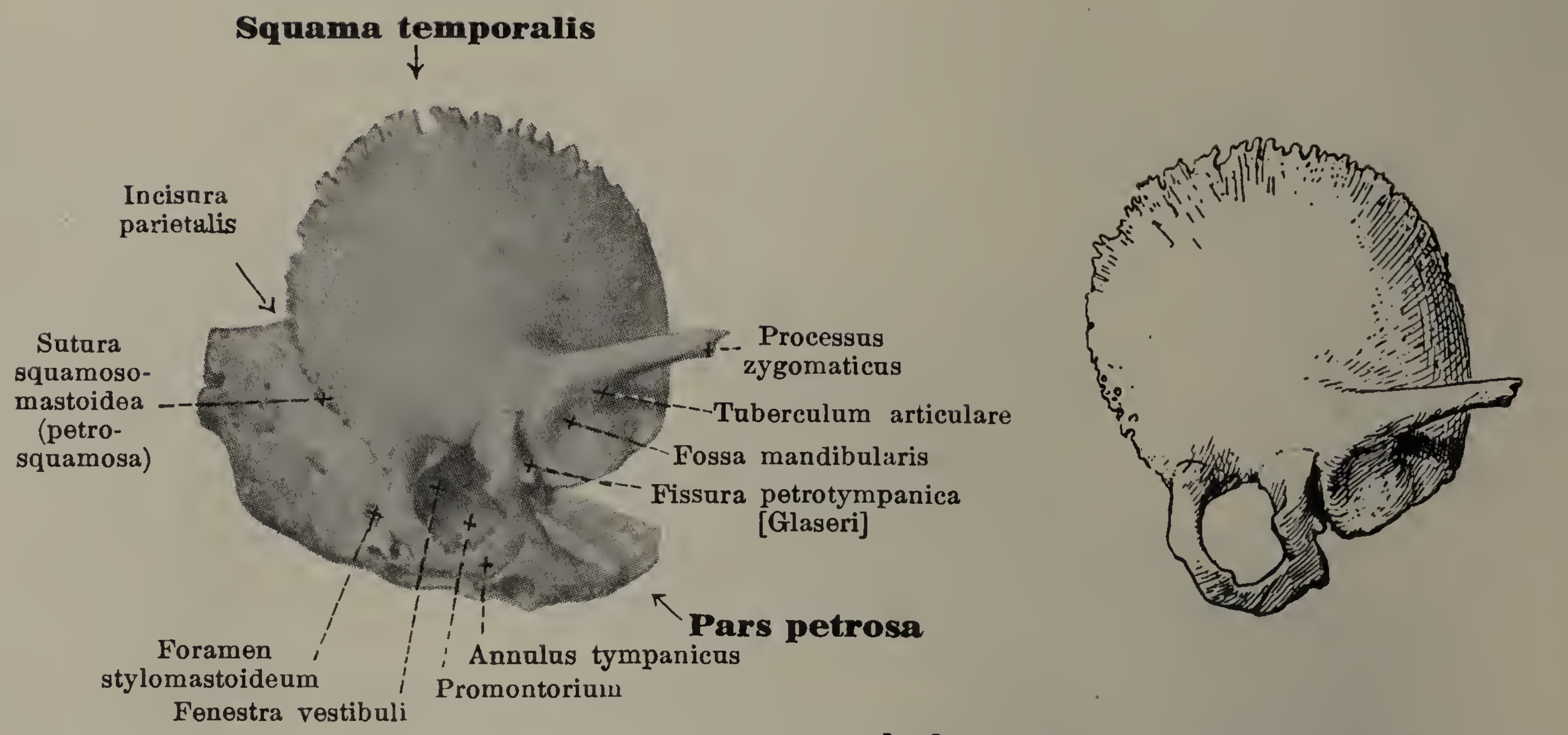
14. Right temporal bone, ***os temporale,*** at the 7th or 8th year of life, seen from without and somewhat from below.

(The pars tympanica has been shelled out and drawn separately in the lower part of the figure; on the right it is seen from the outside, on the left from within.)

The *canaliculi caroticotympanici* (for the r. caroticotympanicus a. carotis internae; nn. caroticotympanici superior et inferior) (see Figs. 11, 493 and 831), usually two in number, are openings or short canals which pass from the posterior wall of the canalis caroticus immediately over the foramen caroticum externum to the cavum tympani and open in the latter on its anterior wall. The *canaliculus mastoideus* (for the r. auricularis n. vagi) (see Figs. 11 and 837) runs as a short, fine canal from the fossa jugularis (see p. 11) lateralward and dorsalward to the lower part of the canalis facialis (see p. 14).

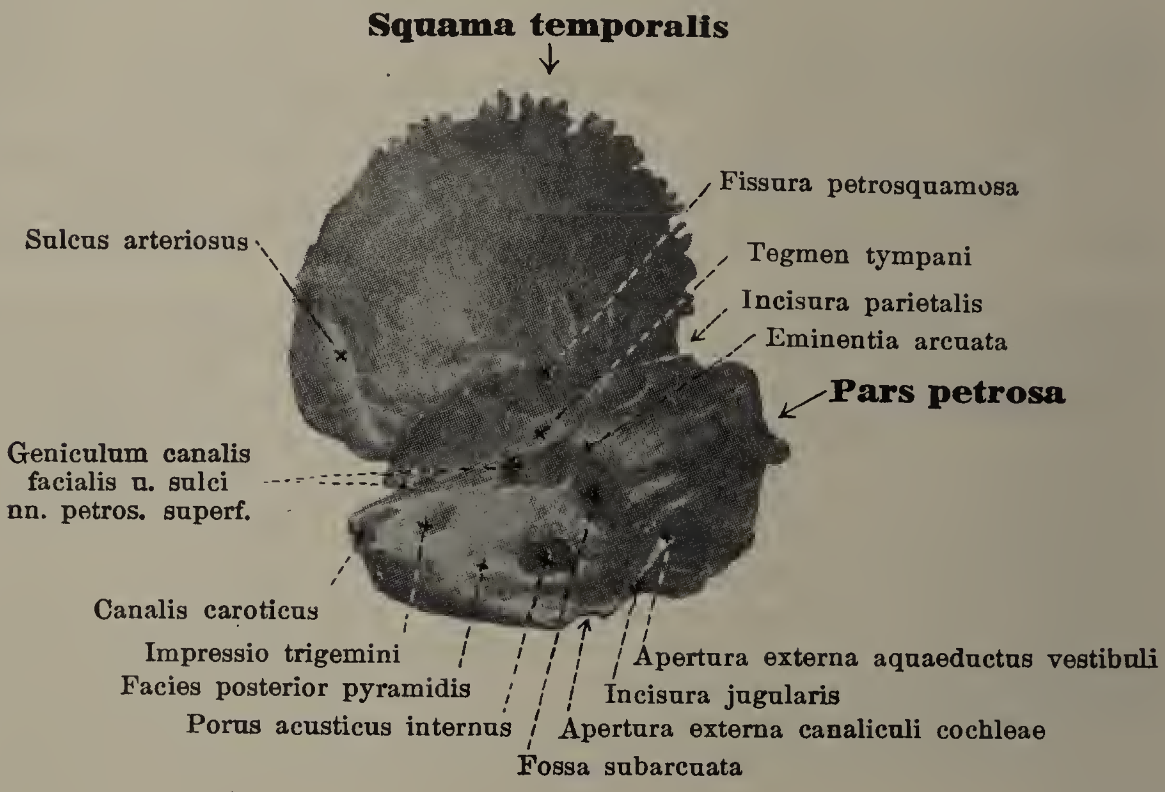
The ***pars tympanica*** (see also Figs. 9 and 965) a platelet of bone hollowed out behind and above in the form of a groove, a nearly flat plate in front and below, presents normally, during the early years of life, a non-ossified portion. The pars tympanica forms the whole anterior, the entire inferior and a part of the posterior wall of the *meatus acusticus externus* as well as the *porus acusticus externus.* The posterior limb of the groove lies upon the anterior surface of the proc. mastoideus and often forms there the so-called *fissura tympanomastoidea.* The anterior limb of the groove is attached to the inferior margin of the squama temporalis just behind the fossa mandibularis; lateralward it is fused for a short distance with the squama, but medianward there exists between the two a narrow platelet of bone, *processus inferior tegminis tympani* (Figs. 9 and 11), which proceeds from the anterior margin of the facies anterior pyramidis and which, with the pars tympanica, form the *fissura petrotympanica [Glaseri]* (O. T. Glaserian fissure). The latter runs into the cavum tympani and presents several small openings for the a. tympanica anterior, vv. tympanicae, chorda tympani and the lig. mallei anterius. Below, surrounding the root of the styloid process from in front like a sheath is a process of the pars tympanica called the *vagina processus styloidei.* (O. T. vaginal process.)

The superior posterior surface of the pars tympanica is smooth and contains at its anterior extremity a groove, bounded by two ridges, the *sulcus tympanicus* (for the membrana tympani), the plane of which looks backward, upward and medianward; at each of the upper angles of the pars tympanica it runs out into a small pointed extremity, the anterior being called the *spina tympanica major*, the posterior, the *spina tympanica minor.* The space between these two spines is not entirely filled up by the attachment of the pars tympanica to the squama temporalis; on the contrary, there remains an indentation called the *incisura tympanica [Rivini]* (see Figs. 945 and 946). The region medial to the sulcus tympanicus aids in forming the lateral wall of the cavum tympani.



15 and 16. Right temporal bone, *os temporale,* from the newborn child, seen from without.

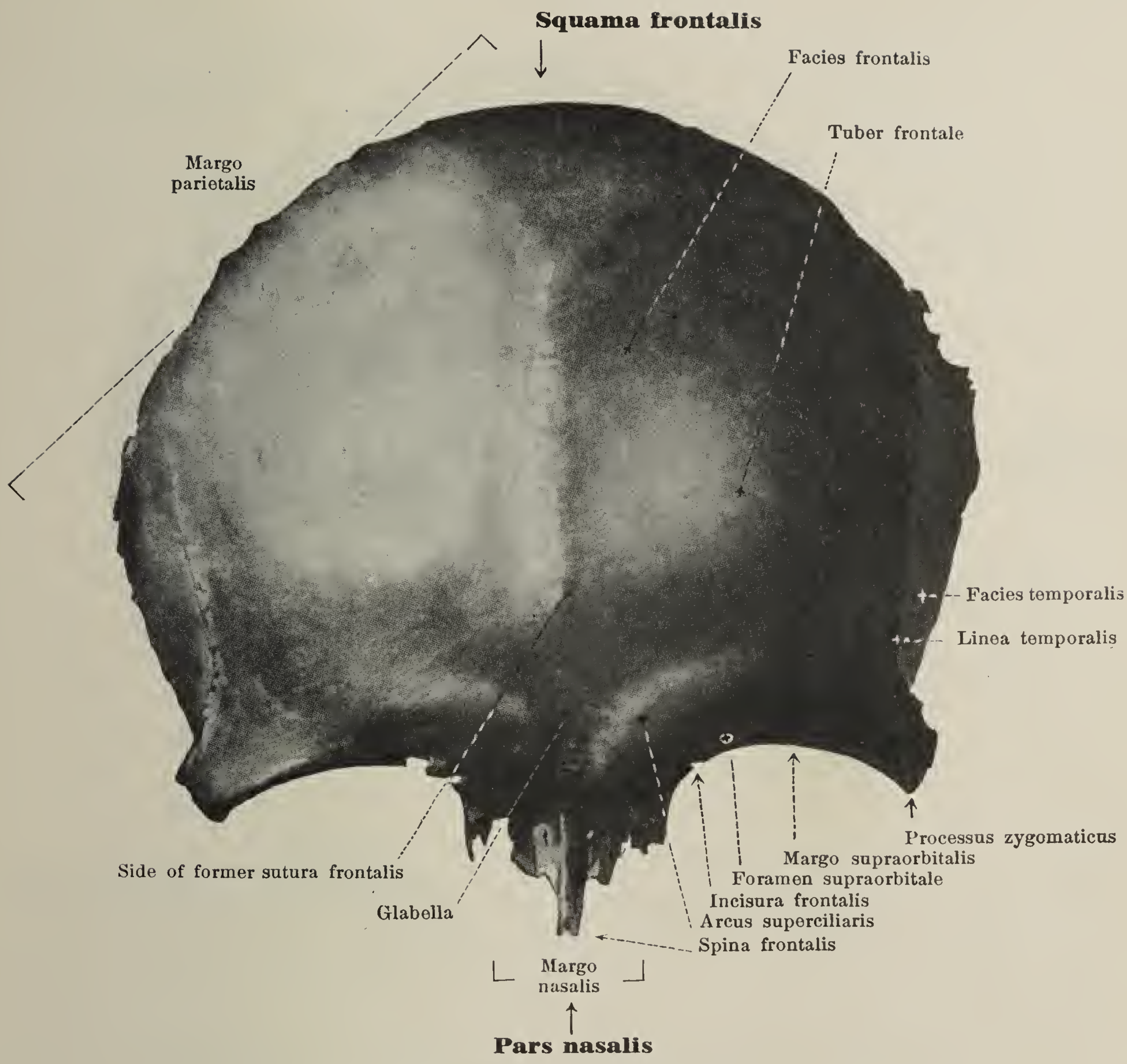
(15: complete, 16: squama temporalis and annulus tympanicus alone.)



17. Right temporal bone, *os temporale,* from newborn child, seen from within.

The **os temporale** consists in the fetus of three main parts: pars petrosa, squama temporalis and pars tympanica (see also pp. 10 and 68); in the newborn it is still divided into all three or into only two parts according as the squama temporalis and pars tympanica still remain separated or have united with one another. The pars tympanica in the newborn is a flat semicircle, the *annulus tympanicus;* it is open above and contains in its concavity the *sulcus tympanicus* (see p. 15); out of it the pars tympanica ultimately develops in that it grows out chiefly in a lateral, less in a medial direction to form a groove.

In the newborn no actual *proc. mastoideus* exists. The *foramen stylomastoideum* lies on the lateral surface of what is later to be the pars mastoidea. The *proc. styloideus* is still cartilaginous for the most part. On the posterior and anterior surface of the pyramid the size of the *fossa subarcuata* (p 11) and the site of the *geniculum canalis facialis* (pp. 11—12) not yet bridged over by bone, are striking features; accordingly, a hiatus canalis facialis, in the sense in which it exists in the adult, is absent in the newborn.

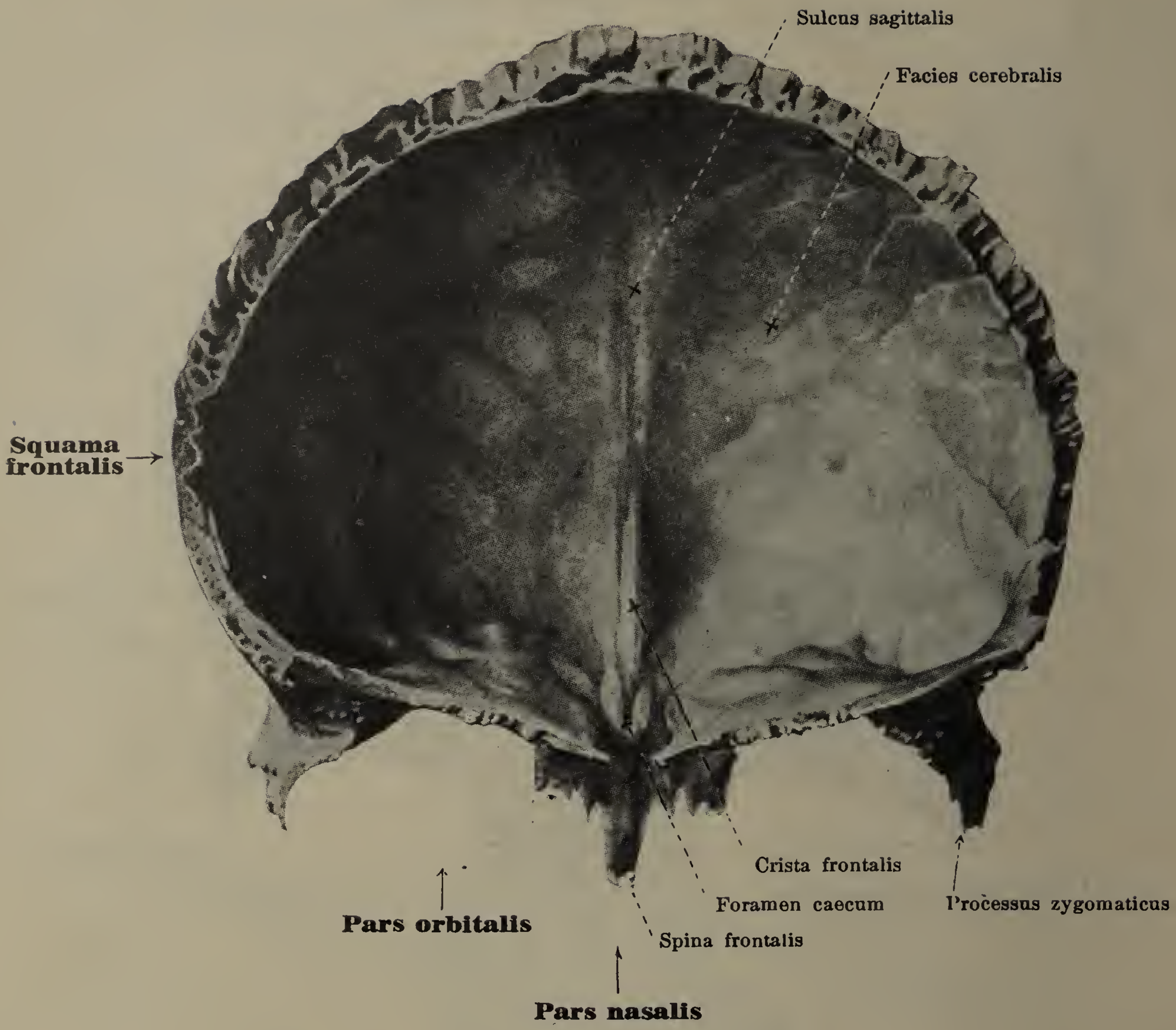


18. Frontal bone, *os frontale,* from in front.

The unpaired **os frontale** *(frontal bone)* (see also Figs. 19, 20, 57—60, 63—68, 70—73 and 76) close the cerebral skull in front. It has four parts, the unpaired *squama frontalis* and *pars nasalis,* and the paired *partes orbitales.* (For development see p. 69.)

The ***squama frontalis*** (see also Figs. 19, 20, 57—60 and 63—68) is curved sagittally and transversely so as to be convex in front. Its largest posterior serrated margin, *margo parietalis,* unites with the frontal margin of the parietal bone to form the *sutura coronalis.* The inferior boundary is formed in the middle by the pars nasalis, lateral from this on each side by the *margo supraorbitalis;* the latter runs out lateralward into the *proc. zygomaticus,* which unites, by means of a rough surface, with the proc. frontosphen. of the zygomatic bone to form the *sutura zygomaticofrontalis.*

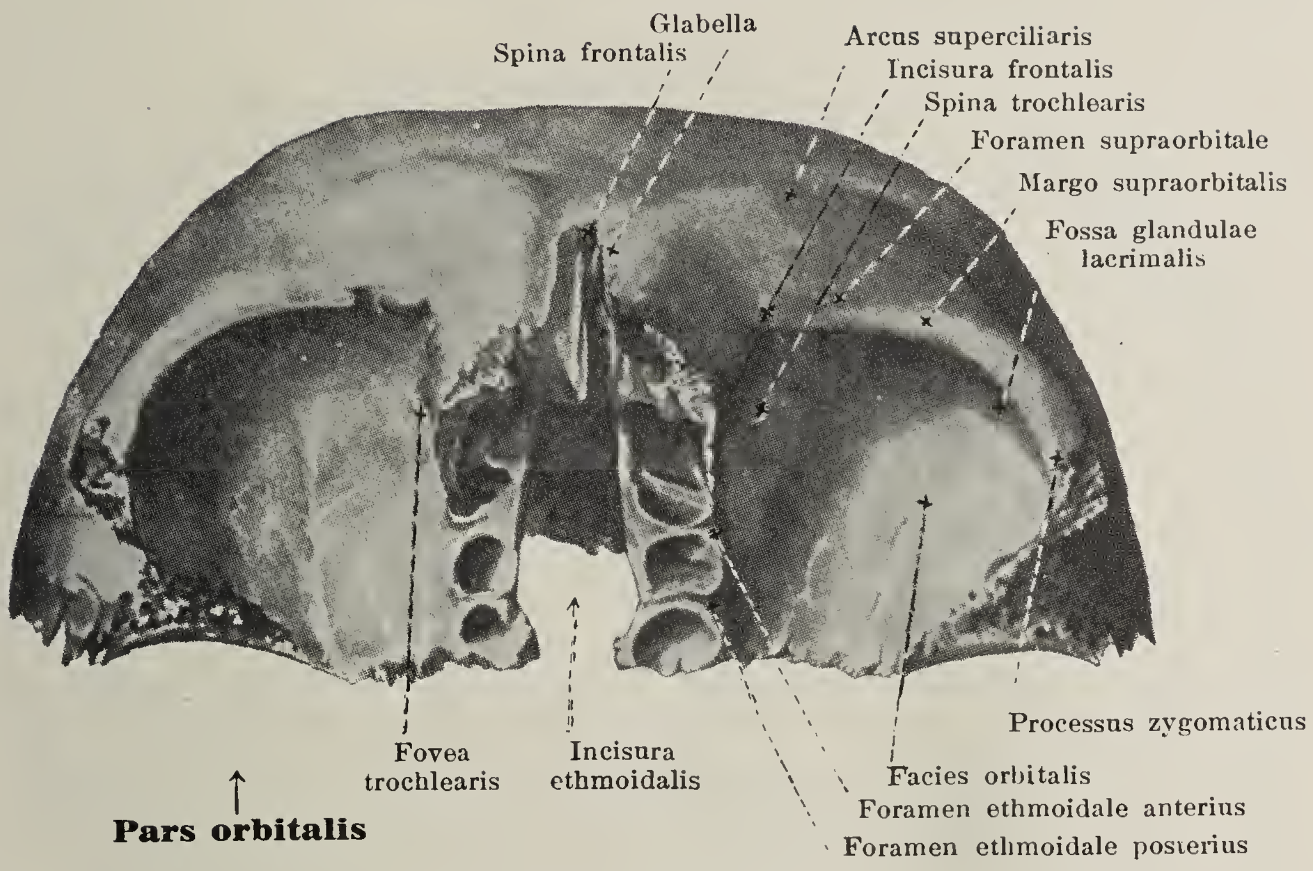
In the medial part of the margo supraorbitalis there is very rarely found a *foramen frontale* (for the a. frontalis; r. frontal. n. frontal.); more often there is a shallow notch, the *incisura frontalis;* but just as often it may be absent; lateralward there lies most commonly another flat notch, the *incisura supraorbitalis* (for the a. supraorbit.; n. supraorbit.); more rarely a *foramen supraorbitale,* and very rarely, neither the one nor the other. The anterior, convex surface, *facies frontalis,* is smooth and rarely presents, in the median plane, in Europeans at most in $7^{0}/_{0}$ of cases, signs of the *sutura frontalis* which is always present at birth (see page 69); lateralward from this on each side lies the *tuber frontale* (O. T. frontal eminence), and lateralward from this the *linea temporalis* ascends backward and upward from the zygomatic process, bounding the flat, nearly sagittally placed, *facies temporalis* (for the m. temporal.). Close to the inferior border. near the median plane on each side, begins a ridge, *arcus superciliaris* (O. T. superciliary ridge), which passes upward and lateralward, flattening as it proceeds; the depressed surface lying between the medial ends of these ridges is called the *glabella.*



19. Frontal bone, *os frontale,* from behind.

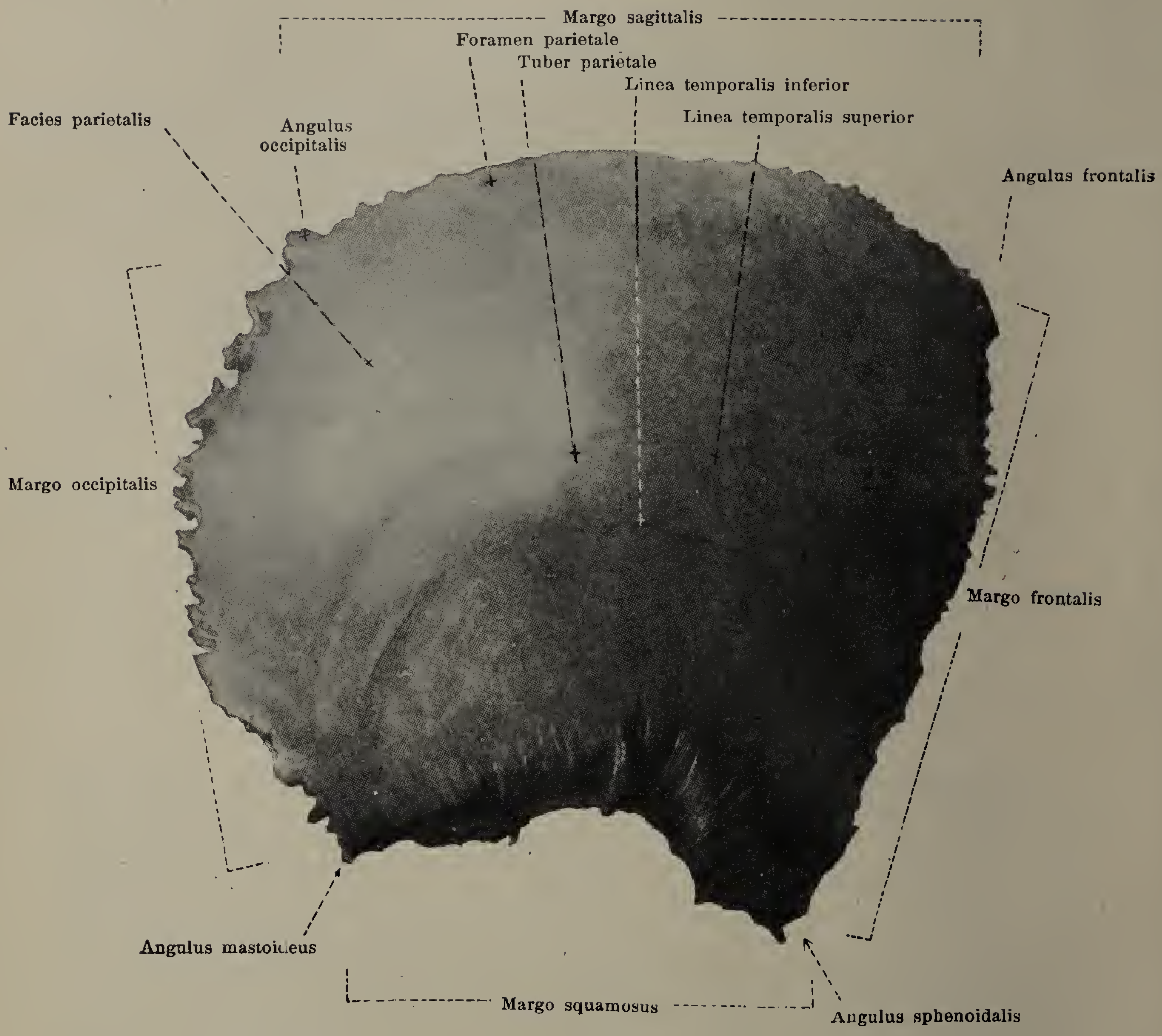
The concave posterior surface of the ***squama frontalis*** (see also Figs. 64—68) forms a part of the *facies cerebralis* (O. T. internal surface) of the frontal bone, which faces towards the anterior skull fossa. In the median plane in the upper part, is a shallow groove, *sulcus sagittalis* (for the sinus sagittalis superior; falx cerebri); out of its lower end develops a narrow, usually markedly projecting sharp ridge, the frontal crest or *crista frontalis* (for the falx cerebri), which below, forms the anterior boundary of the foramen caecum. Shallow juga cerebralia and impressiones digitatae (see p. 5) are visible, chiefly in front, below and behind.

The term ***pars nasalis*** (see also Figs. 18, 20, 57—60 and 76—78) is applied to the part projecting somewhat from the inferior margin of the squama frontalis in the middle; it separates the two partes orbitales from one another. In front it is bounded by the slightly serrated *margo nasalis;* to which the nasal bone is attached on each side *(sutura nasofrontalis);* immediately adjacent is attached the proc. frontalis maxillae *(sutura frontomaxillaris).* The posterior free margin is the anterior part of the *incisura ethmoidalis;* it unites with the anterior margin of the lamina cribrosa oss. ethmoidalis and forms a part of the *sutura frontoethmoidalis.* Obliquely downward and forward from the inferior rough surface projects the *spina frontalis* (O. T. nasal spine). It is rough in front for the further attachment of the nasal bones and of the frontal processes of the maxillae; its posterior, partly smooth, partly rough surface is applied medianward to the crista galli and lamina perpendicularis oss. ethmoidalis, lateralward to the medial wall of the ethmoidal labyrinth; between these the posterior surface helps to form also the anterior wall of the nasal cavity. On the upper surface, close behind the inferior extremity of the crista frontalis, lies the entrance (usually formed by the frontal bone alone) to the *foramen caecum,* a canal which grows smaller as it descends and ends blindly in the apex of the spina frontalis; it contains a process of the dura mater.



20. Frontal bone, *os frontale,* from below.

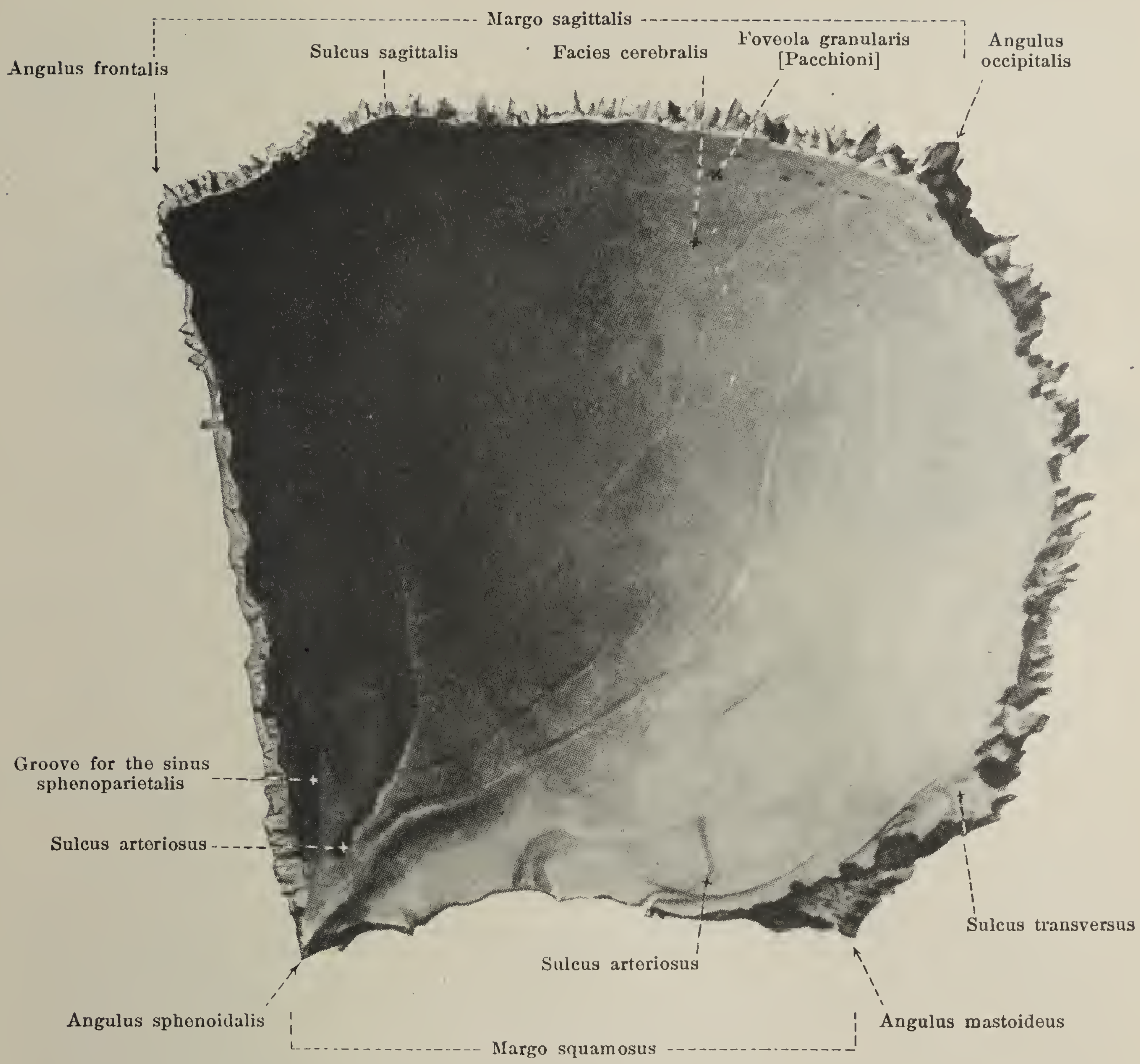
Tho ***partes orbitales*** (see also Figs. 19, 65—68 and 70—73) pass at a right angle from the inferior margin of the squama frontalis backward and are separated from one another by the quadrangular *incisura ethmoidalis* cutting in from behind. The anterior boundary is formed by the *margo supraorbitalis;* the lateral by the *processus zygomaticus.* The posterior margin is slightly serrated medianward for union with the ala parva oss. sphenoid., and is continuous lateralward toward the proc. zygomat. with a triangular rough surface for contact with the margo frontalis of the ala magna oss. sphenoid. *(sutura sphenofrontalis);* behind this surface lies a variable, narrow, sickle-shaped, smooth field, which along with the ala parva oss. sphenoid. helps to form the middle fossa of the skull. The medial border, bounding the incisura ethmoidalis, is only slightly rough and forms with the lateral margin of the lamina cribrosa oss. ethmoid. a part of the *sutura frontoethmoidalis.* Parallel to this margin a rough ridge runs lateralward to which are attached in front the os lacrimale by the *sutura frontolacrimalis,* behind the lamina papyracea oss. ethmoid. by a part of the *sutura frontoethmoidalis.* The oblong field lying between this ridge and the medial border is irregularly divided by thin transverse ridges, lies upon the upper surface of the ethmoidal labyrinth and presents bulgings due to the cellulae ethmoidales which extend into it; two grooves, running frontally, form with corresponding grooves of the ethmoidal labyrinth the *foramen ethmoidale anterius* (for the a. ethmoid. ant.; n. ethmoid. ant.) and the *foramen ethmoidale posterius* (for the a. ethmoid. poster.; n. ethmoid. poster.; rr. orbital. gangl. sphenopalat.). The inferior surface of the pars orbit., *facies orbitalis,* faces towards the orbit, is smooth and presents near its medial anterior angle a small depression, the *fovea trochlearis* (and occasionally posteriorly near it a small spur, *spina trochlearis)* (for the trochlea m. obliqui oculi super.); in the lateral portion, bounded in front by the margo supraorbit., lateralward by the proc. zygomat., lies the *fossa glandulae lacrimalis* (for the glandula lacrim. sup.). The upper surface, *facies cerebralis,* forms the lower part of the anterior cranial fossa and presents strong juga cerebralia and impressiones digitatae (see p. 5). At the junction of the partes orbitales with the squama frontalis the bone contains within it the *sinus frontales* or *frontal sinuses* (see also Fig. 567), two cavities between the plates of the partes orbitales and the squama of varying width and lined by mucous membrane. They are subdivided by the *septum sinuum frontalium,* which usually diverges somewhat from the median plane. Both of them have approximately the shape of a three-sided pyramid having the base below and the apex above; their entrances lie in the anterior medial angles of the partes orbitales. The sinus frontales are occasionally tough very rarely absent on one or both sides.



21. Right parietal bone, *os parietale,* from without.

The **os parietale** *(parietal bone)* (see also Figs. 22, 57, 58, 63—68) is paired and helps to form the roof and lateral wall of the skull. It is a quadrangular, flat, saucer-shaped bone with an external, convex *facies parietalis* and an internal, concave *facies cerebralis.* (For the development see p. 69.)

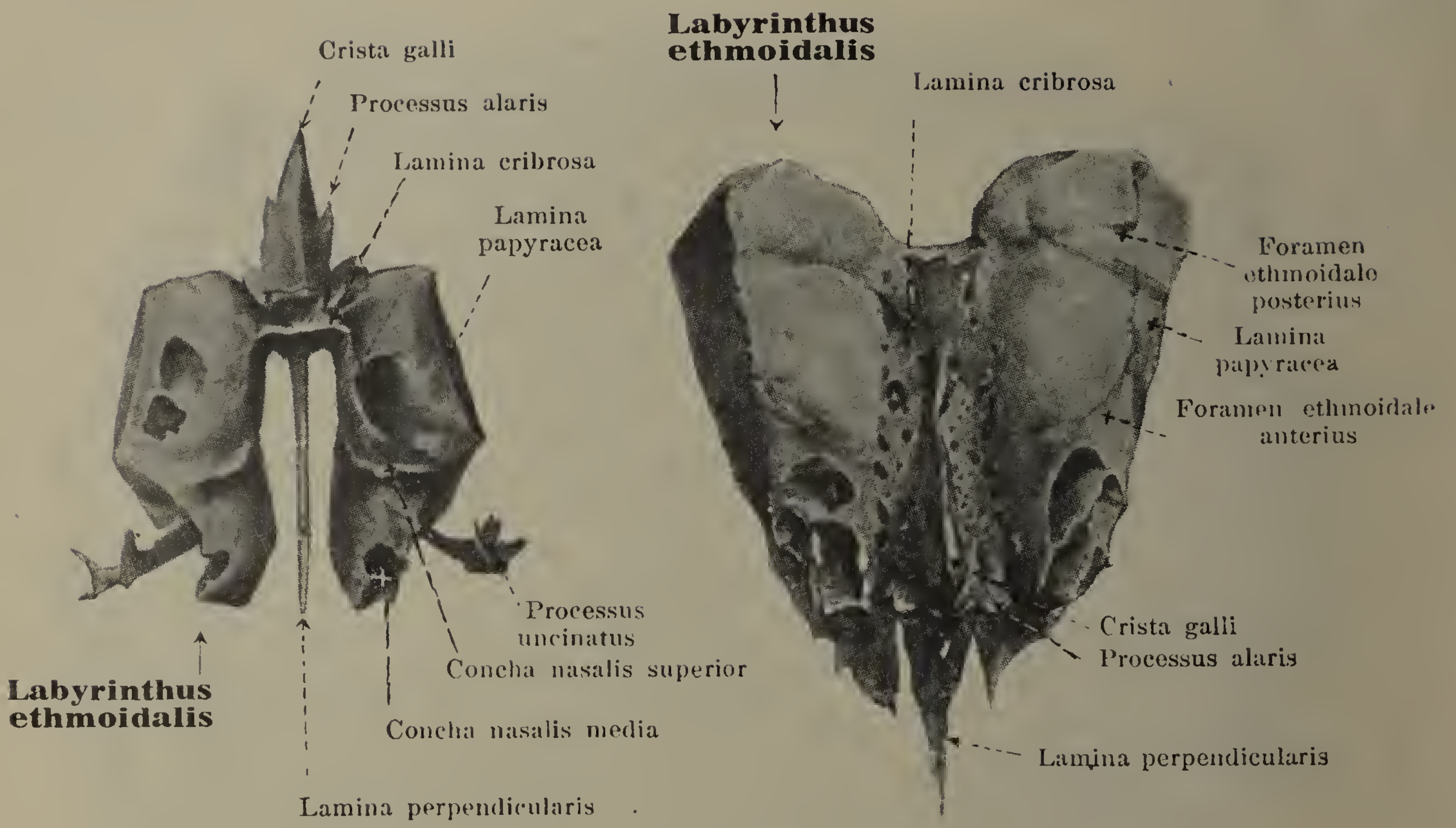
The bone has four margins, and four angles. The posterior convex margin, *margo occipitalis,* is deeply serrated and unites with the margo lambdoideus oss. occip. to form the *sutura lambdoidea.* The inferior margin, *margo squamosus,* is concave and bevelled from without; it is attached to the margo parietal. oss. tempor. *(sutura squamosa).* The anterior, slightly concave margin, *margo frontalis,* is serrated and unites with the margo parietal. oss. front. to form the *sutura coronalis,* and the upper straight, markedly serrated margin, *margo sagittalis,* forms with the same margin of the opposite parietal bone the *sutura sagittalis.* The anterior superior angle, *angulus frontalis,* lies in the middle of the sutura coronalis and adjoins the frontal bone; the posterior superior *angulus occipitalis,* adjoins the upper extremity of the squama occipitalis. The posterior inferior angle, *angulus mastoideus,* is inserted in the incisura parietal. oss. tempor. and forms there with the upper margin of the pars mastoid. oss. tempor. the *sutura parietomastoidea.* The anterior inferior angle, *angulus sphenoidalis,* is bevelled from without, attached to the angul. pariet. of the ala magna oss. sphenoid. and forms with this the *sutura sphenoparietalis.*



22. Right parietal bone, *os parietale*, from within.

The ***facies parietalis*** (see Figs. 21, 57, 58 and 63) is more or less markedly bulged out in the middle; this projection is called the *tuber parietale.* Below it runs the *linea temporalis inferior*, convex above, which begins at the margo frontalis as a continuation of the linea temporalis oss. frontalis and goes over at the angulus mastoideus into the linea temporalis oss. temporalis; it itself and the field beneath give origin to the m. temporalis. More or less concentric with it runs generally a less marked *linea temporalis superior,* which ends at the margo occipitalis; to it is attached the fascia temporalis. Close to the margo sagittalis there is very often, in the posterior third, an opening, the *foramen parietale* (for the r. meningeus a. occipitalis, emissarium parietale).

On the ***facies cerebralis*** which faces towards the skull cavity (see also Figs. 64—68) along the margo sagittalis runs a groove, completed by apposition with the parietal bone of the other side, the *sulcus sagittalis* (for the sinus sagittalis sup.; falx cerebri), into which the foramen parietale usually opens. Over the inner surface of the angulus mastoid. runs a short, broad, flat groove, the *sulcus transversus* (O. T. groove for lateral sinus) (for the sinus transvers.). At the angulus sphenoid. is found a deep *sulcus arteriosus* which undergoes tree-like branching upward, close in front of the angulus mastoideus is a second less branched; both form sometimes, for a short distance, an actual canal, for branches of the a. mening. med.. In addition the facies cerebralis presents *impressiones digitatae* and *juga cerebralia* (see p. 5) and also frequently, especially in older people, near the sulcus sagittalis, *foveolae granulares [Pacchioni]* (O. T. Pacchionian depressions) (for the granulationes arachnoideales [Pacchioni]). Corresponding to the tuber parietale there is, on the inner surface, a depression, *fossa parietalis,* in the region of which the bone is thinned.

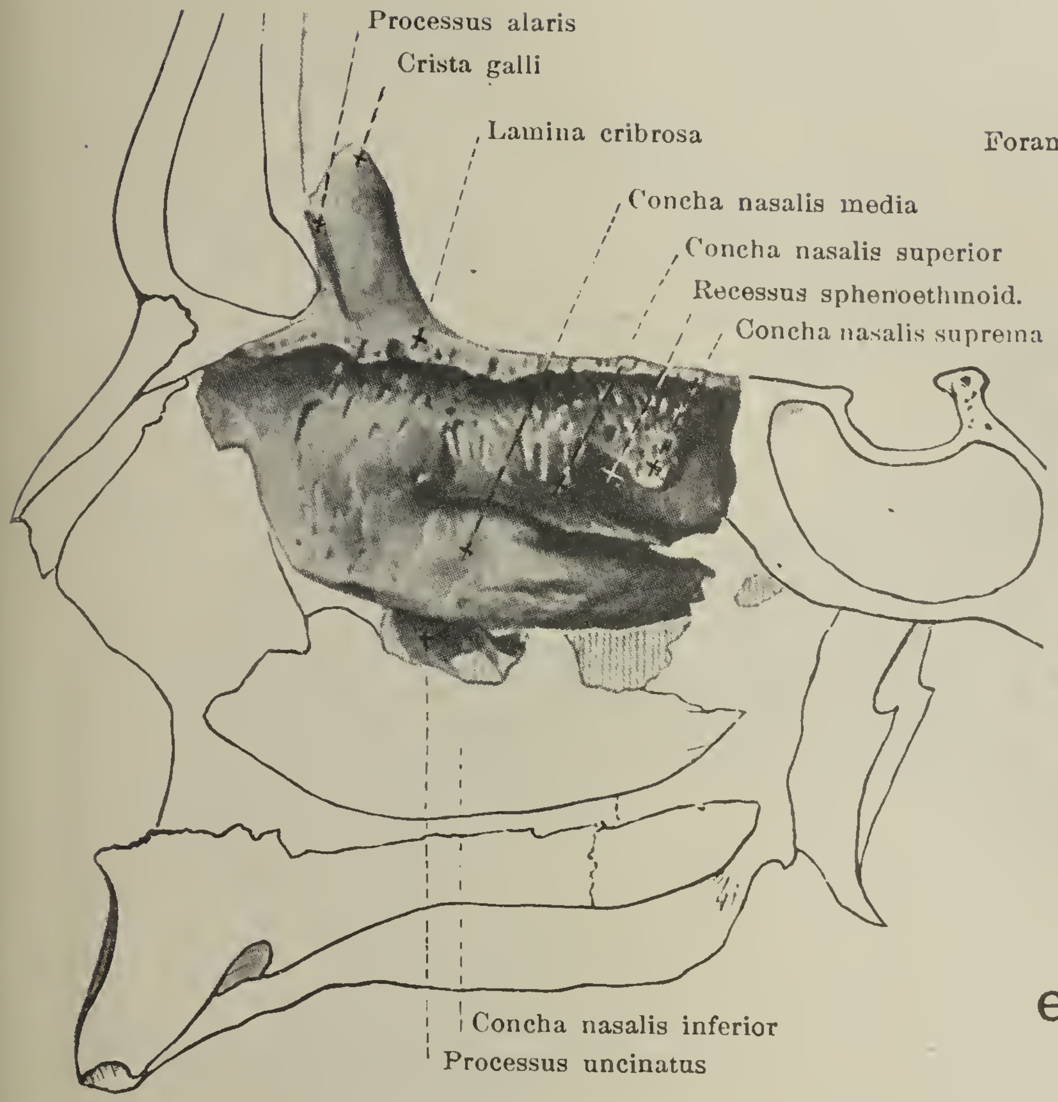


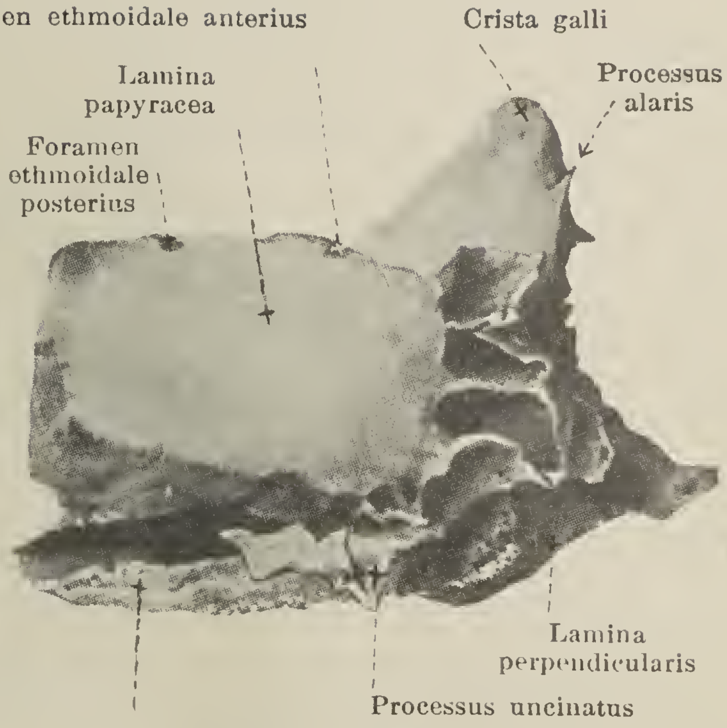
23 and 24. Ethmoid bone, *os ethmoidale,*

from behind, somewhat schematic. from above.

The os **ethmoidale** *(ethmoid bone)* (see also Figs. 25—27, 65, 66, 70—72, 76—78) is unpaired, helps in part to close the most anterior portion of the cerebral skull below, but reaches with its main mass deep down into the facial skull and helps to form the nose and orbit. It consists above of a transversely placed oblong plate, the *lamina cribrosa;* from the under surface of this extending downward in the median plane is the *lamina perpendicularis* and from each of its two lateral borders hangs the *labyrinthus ethmoidalis;* in contact with its posterior surface is the concha sphenoidalis, which apparently seems to be part of the os sphenoidale but in reality belongs embryologically to the os ethmoidale (see p. 6). (Development see p. 69.)

The ***lamina cribrosa*** *(cribriform plate)* (see also Figs. 25, 65—68 and 74—78) lies horizontally, fills the incisura ethmoidalis oss. frontalis completely and thus forms at the anterior and the two lateral margins a part of the *sutura frontoethmoidalis:* the posterior margin lies on the anterior border of the upper surface of the body of the sphenoid bone *(sutura sphenoethmoidalis).* The cribriform plate presents on its upper surface, facing towards the anterior skull fossa, in the median plane a ridge which becomes elevated in front to form the oblong *crista galli* or *cock's comb* (for the falx cerebri); this is higher in front than behind and consists of solid bone tissue or sometimes contains bone-marrow spaces; it is attached to the pars nasalis and crista frontalis oss. frontalis, usually by means of the two small, laterally directed *processus alares,* and completes the entrance to the foramen caecum oss. frontalis when this is incomplete. The cribriform plate is perforated by numerous foramina of different sizes, the larger of which are arranged often in two rows, one medial and one lateral, and which are continued in small grooves on the lamina perpendicularis and on the medial surface of the labyrinth; they give passage to the nn. olfactorii. A small slit lateralward from the anterior part of the crista galli gives passage to the a. and the n. ethmoidalis anterior. The lower surface of the lamina cribrosa forms the upper wall of the nasal cavity.



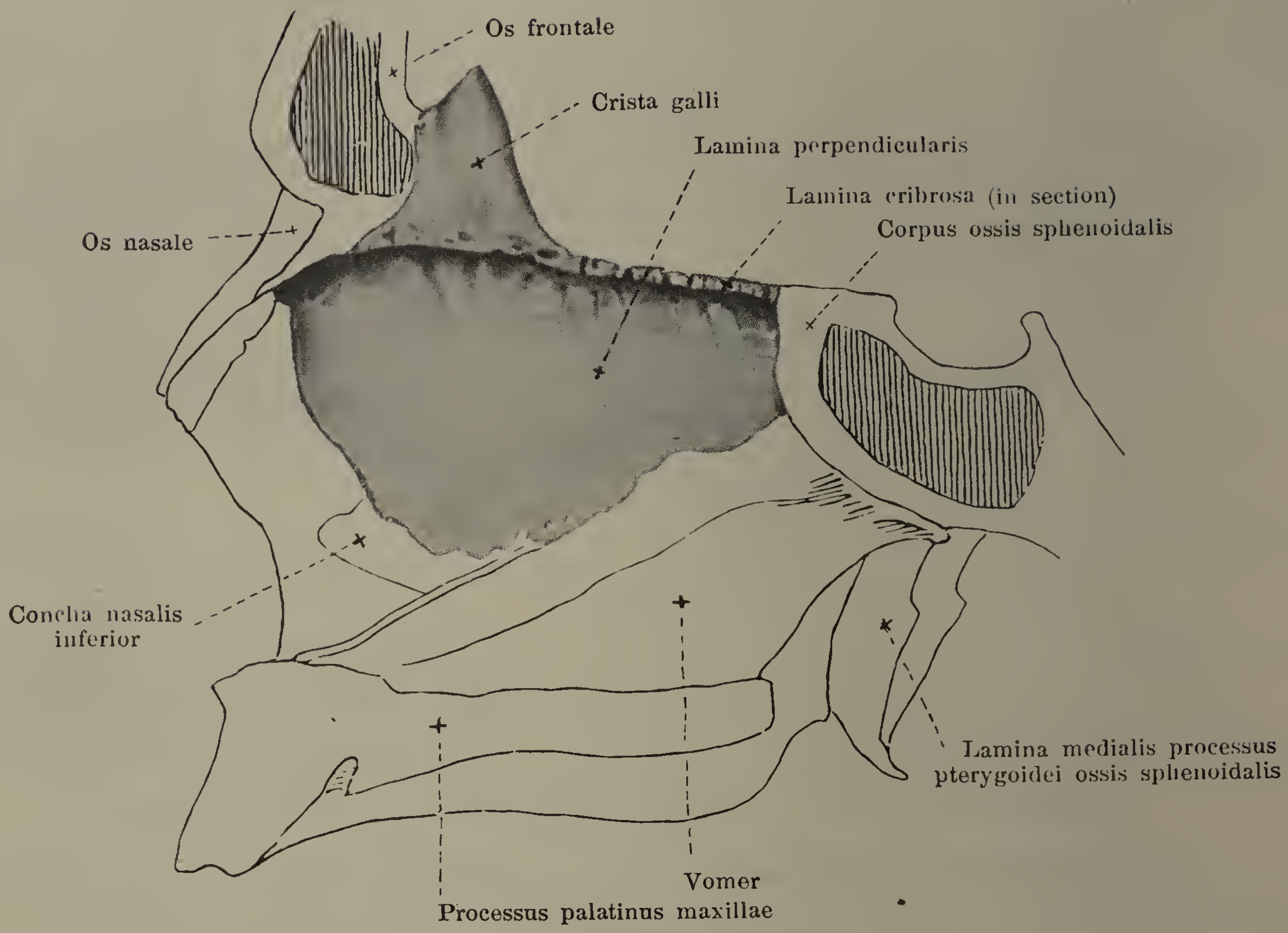


25 and 26. Right ethmoidal labyrinth, *labyrinthus ethmoidalis,*

from within

from without.

Each ***labyrinthus ethmoidalis*** (O. T. lateral mass of ethmoid) (see also Figs. 23, 24, 67, 68, 70, 72, 74—78, 567) is oblong and hexagonal in shape, and is connected only above and medianward with the lateral border of the lamina cribrosa. Inside it is divided by delicate platelets of bone into the numerous *cellulae ethmoidales (ethmoid cells)* lined by mucous membrane and communicating with each other. These gradually grow larger in the course of development, so that they finally project beyond the limits of the ethmoid bone. They consist of fully formed bone tissue only on the medial surface, and on the lateral surface are for the most part enclosed by the walls of the ethmoid; otherwise they project against neighboring bones, or into them; thus in the isolated bone they partly open and become closed cavities only by the attachment of adjacent bones; in front the pars nasalis oss. frontalis and proc. frontalis maxillae, lateralward by the os lacrimale and corpus maxillae, behind by the proc. orbitalis oss. palatini, corpus oss. sphenoidalis and conchae sphenoidales, above by the pars orbitalis oss. frontalis. Spread out on the latter surface of union are the *foramen ethmoidale anterius* (for the a. ethmoid. ant.; n. ethmoid. ant.) and the *foramen ethmoidale posterius* (for the a. ethmoid. post., n. ethmoid. post., rr. orbit. gangl. sphenopalat.) (see also p. 19). The lateral wall of the labyrinth, *lamina papyracea* (O. T. os planum), is oblong, quadrangular, and unites in front with the os lacrimale, below with the corpus maxillae *(sutura ethmoideomaxillaris)*, behind with the proc. orbital. oss palat. *(sutura palatoethmoidalis)* and the corpus oss. sphenoid. *(sutura sphenoethmoidalis)*, above with the pars orbital. oss. front. *(sutura frontoethmoidalis)*. The medial wall is vertical, is very rough, and much perforated, presenting small vertical slits for the nn. olfactorii. Its anterior margin is attached to the posterior surface of the spina frontalis oss. frontalis, its posterior border to the anterior surface of the concha sphenoidalis; the inferior thickened border hangs down free, bends around somewhat lateralward, and thus forms the *concha nasalis media (middle turbinated bone)*; above this in the posterior part is a deep notch *(meatus nasi superior, upper nasal passage)* and above this a similar, concha-like plate of bone, bent so as to be convex medianward, the *concha nasalis superior (superior turbinated bone)*; further backward and upward lies usually still another turbinated bone, the *concha nasalis suprema [Santorini]*, separated from the preceding by a groove, the *recessus sphenoethmoidalis*. Lateralward from the anterior extremity of the concha media, a sickle-shaped process, the *processus uncinatus* (O. T. unciform process), directed backward, becomes separated from the inferior wall; at its extremity it rolls around lateralward, and below or behind this place unites with the proc. ethmoidalis conchae nasalis inferioris (see also Figs. 70 and 77).


Os frontale
Crista galli
Lamina perpendicularis
Lamina cribrosa (in section)
Corpus ossis sphenoidalis
Os nasale
Concha nasalis inferior
Lamina medialis processus pterygoidei ossis sphenoidalis
Vomer
Processus palatinus maxillae

27. Ethmoid bone, *os ethmoidale, lamina perpendicularis,*

from the left.

The ***lamina perpendicularis*** or *perpendicular plate* (see also Figs. 23, 67, 68, 78, 567, and 979) is quadrangular with unequal sides; at its upper border in the median plane it is in large part united to the inferior surface of the lamina cribrosa; it hangs down perpendicularly and free between the two labyrinths and thus forms a part of the bony nasal septum. At its upper margin it presents small grooves which are continuations of the medial foramina of the lamina cribrosa for the nn. olfactorii. The upper border is attached in front to the posterior surface of the spina frontalis oss. frontalis *(sutura frontoethmoidalis);* the posterior margin unites with the crista sphenoidalis oss. sphenoidalis *(sutura sphenoethmoidalis),* the inferior with the anterior margin of the vomer, the anterior with the cartilaginous nasal septum.

Deviations of the lamina perpendicularis as a whole or in single spots from the median plane are very frequent.

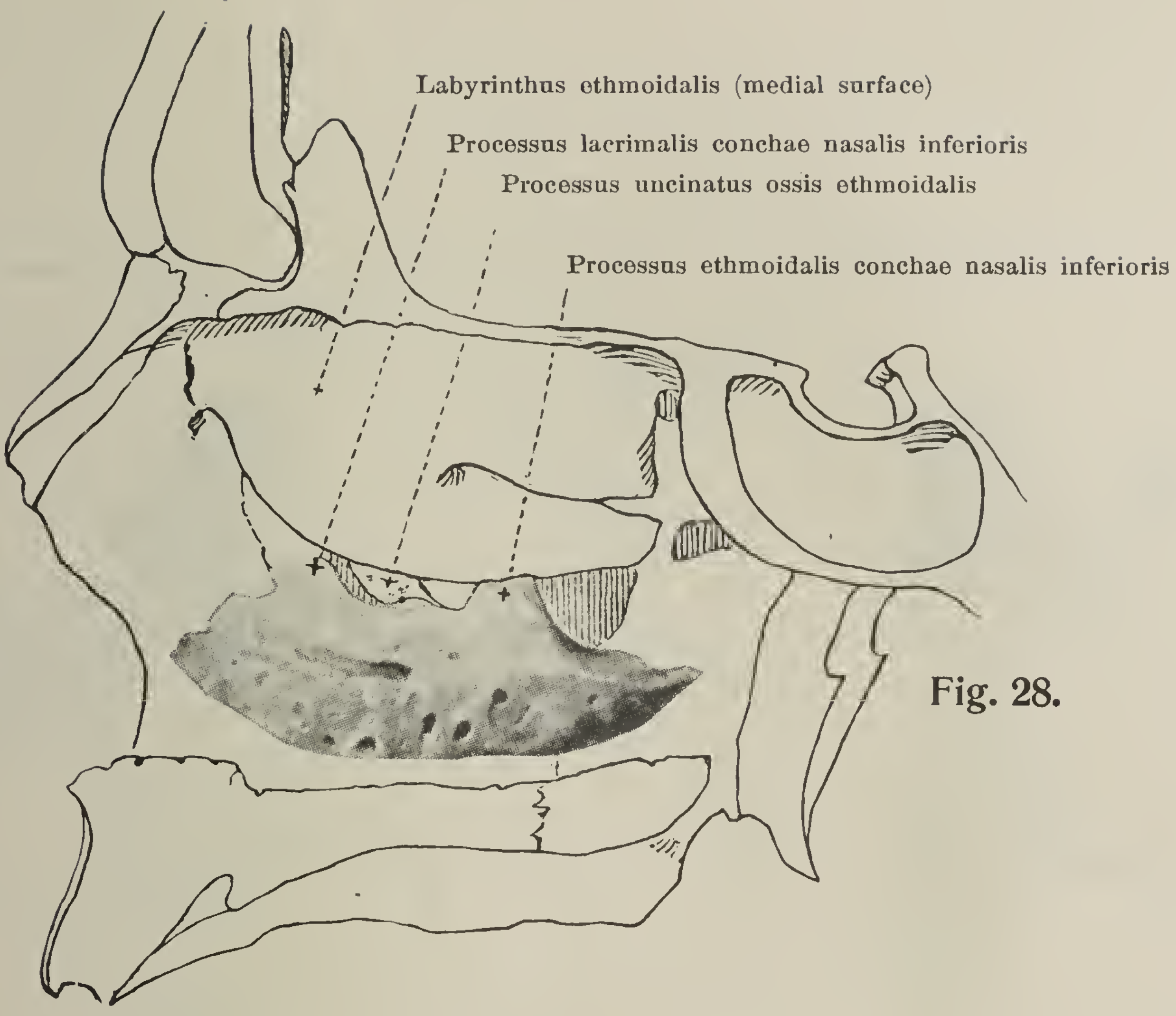

Labyrinthus ethmoidalis (medial surface)
Processus lacrimalis conchae nasalis inferioris
Processus uncinatus ossis ethmoidalis
Processus ethmoidalis conchae nasalis inferioris

Fig. 28.

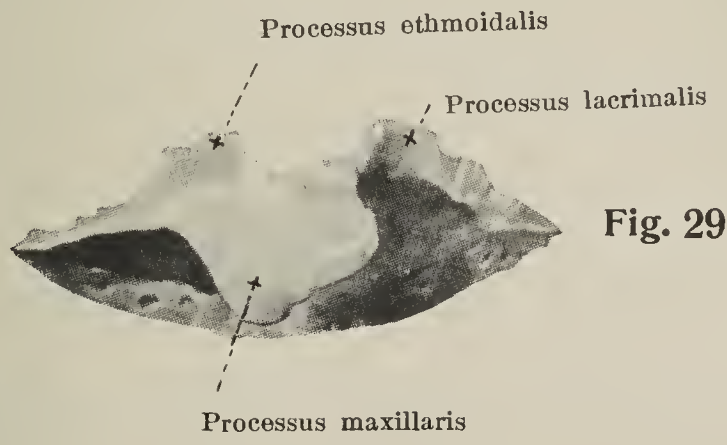
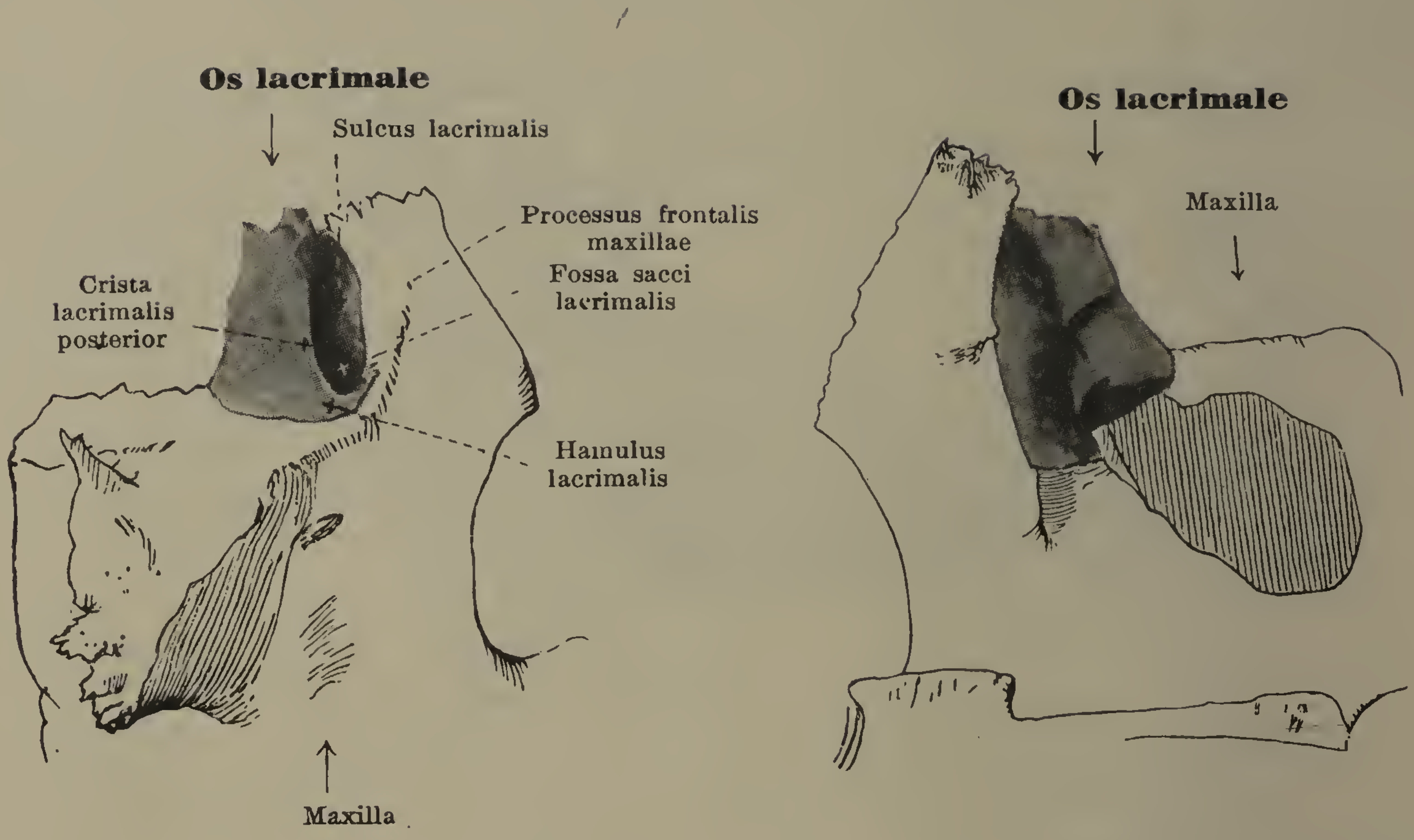


Fig. 29.

28 and 29. Right inferior turbinated bone, *concha nasalis inferior.*

Fig. 28 Above, from within. Fig. 29 Below, from without.

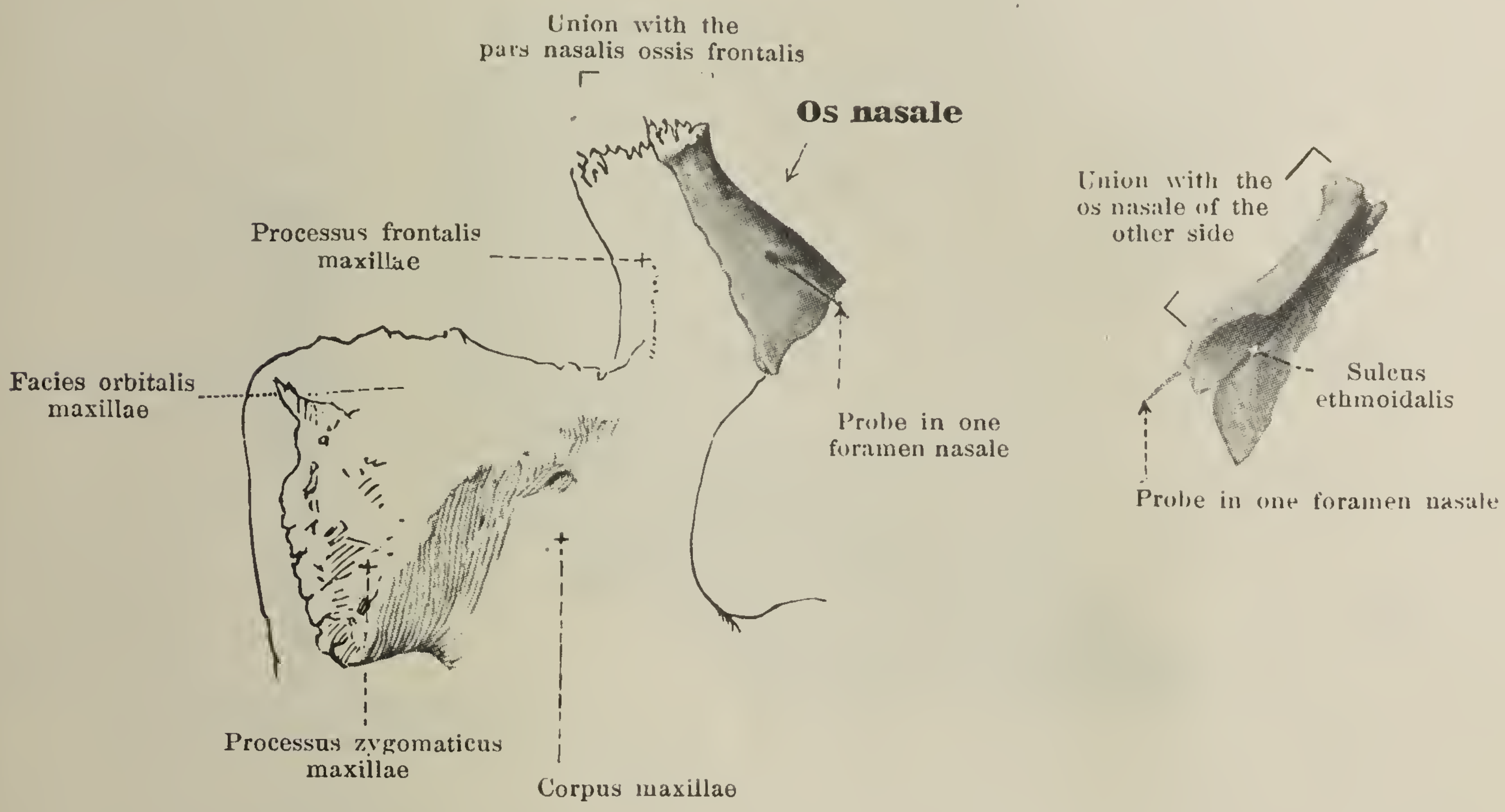
The **concha nasalis inferior** ***(inferior turbinated bone)*** (see also Figs. 70, 76, 77 and 567) is paired; it lies on each side in the lower part of the lateral wall of the nasal cavity and is placed sagitally in its longest diameter. It is oblong, very porous, bent so as to be convex medianward, and hangs downward as a free mass from its upper attached margin. The inferior border is much thickened and lateralward somewhat rolled. The upper thinner margin is attached in front to the crista conchalis maxillae and gives off close behind this point the ***processus lacrimalis***, directed obliquely upward and forward, which unites with the inferior margin of the os lacrimale ***(sutura lacrimoconchalis)*** and helps the sulcus lacrimalis maxillae (see p. 30) to complete the ***canalis nasolacrimalis.*** Somewhat further backward the broad ***processus maxillaris*** projects lateralward and downward, so as to lie on the inferior circumference of the hiatus maxillaris; above this broad process arises the narrower, more irregular ***processus ethmoidalis*** which passes upward to unite with the processus uncinatus oss. ethmoidalis. The most posterior part of the upper margin is attached to the crista conchalis oss. palatini. (For development see p. 69.)



30 and 31. Right lachrymal bone, *os lacrimale,*

from without. from within.

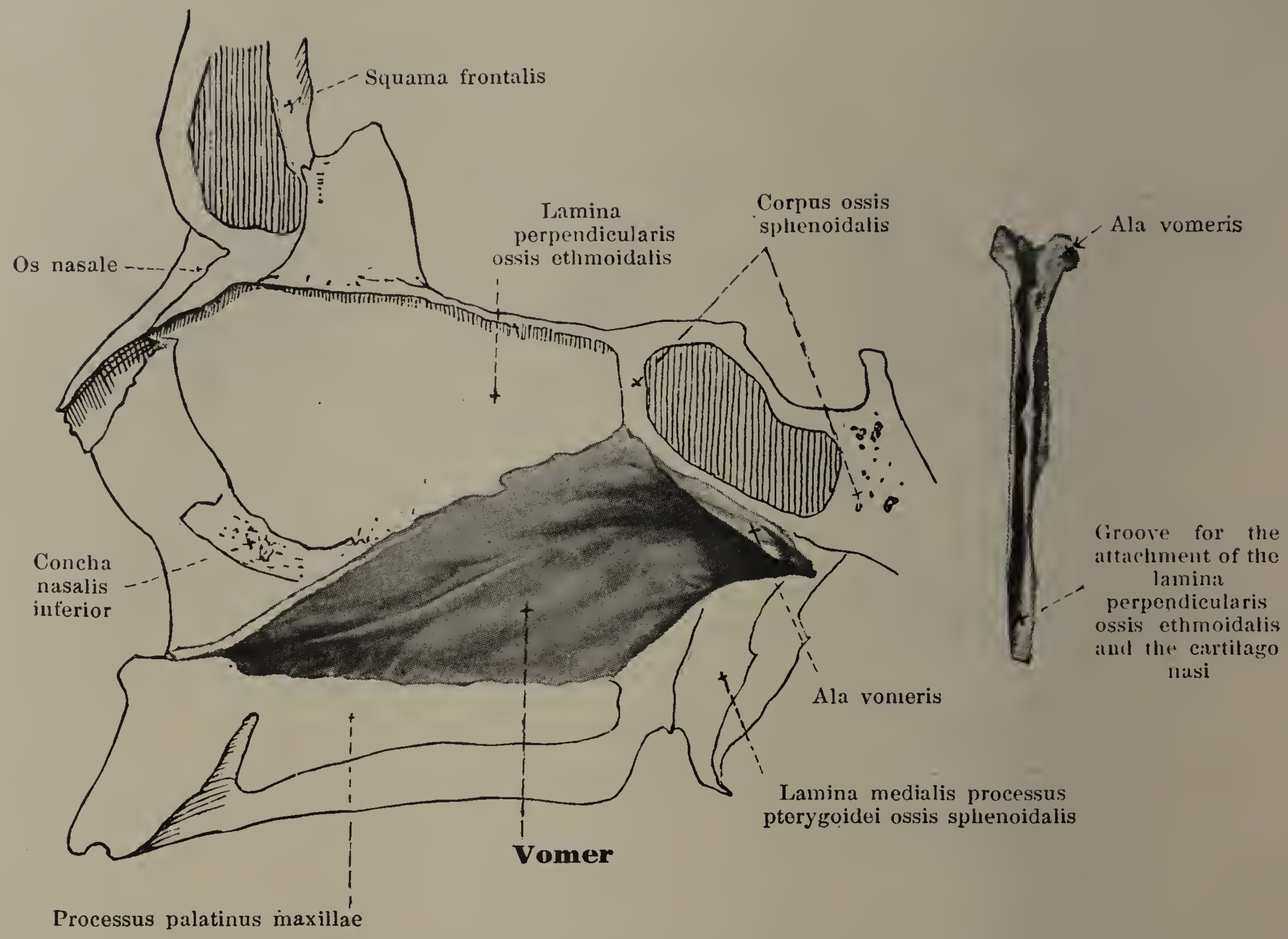
The **os lacrimale** *(lachrymal bone)* (see also Figs. 70—72, 76 and 77) is a paired, oblong, quadrangular, thin platelet of bone, the size of a finger nail, and lies in the anterior part of the medial wall of the orbit. The upper margin unites with the pars orbitalis oss. frontalis *(sutura frontolacrimalis)* (s. p. 19); the posterior margin with the anterior border of the lamina papyracea oss. ethmoidalis; the inferior margin behind with the medial margin of the facies orbitalis of the corpus maxillae *(sutura lacrimomaxillaris)*, in front with the proc. lacrimalis conchae nasalis inferioris *(sutura lacrimoconchalis)*; the anterior margin with the margo lacrimalis of the proc. frontalis maxillae *(sutura lacrimomaxillaris)*. The medial surface is tolerably flat, lies directly on the anterior part of the lateral wall of the ethmoidal labyrinth and forms the lateral wall of the anterior ethmoidal cells; the lateral surface is divided by a crest extending from above downward, the ***crista lacrimalis posterior*** (O. T. lachrymal crest) (for the origin of the pars lacrimalis m. orbicularis oculi), into a larger posterior level area and a smaller anterior concave area, ***sulcus lacrimalis***; the latter forms with the sulcus lacrimalis of the proc. frontalis maxillae the ***fossa sacci lacrimalis*** (for the saccus lacrimalis). From the inferior extremity of the crista lacrimalis posterior proceeds the somewhat variable ***hamulus lacrimalis*** (O. T. hamular process) lateralward, forward and downward; it is inserted in the incisura lacrimalis on the medial anterior margin of the orbital surface of the body of the maxilla (see also p. 30). (For development see p. 69.)



32 and 33. Right nasal bone, *os nasale,*

from without. from within.

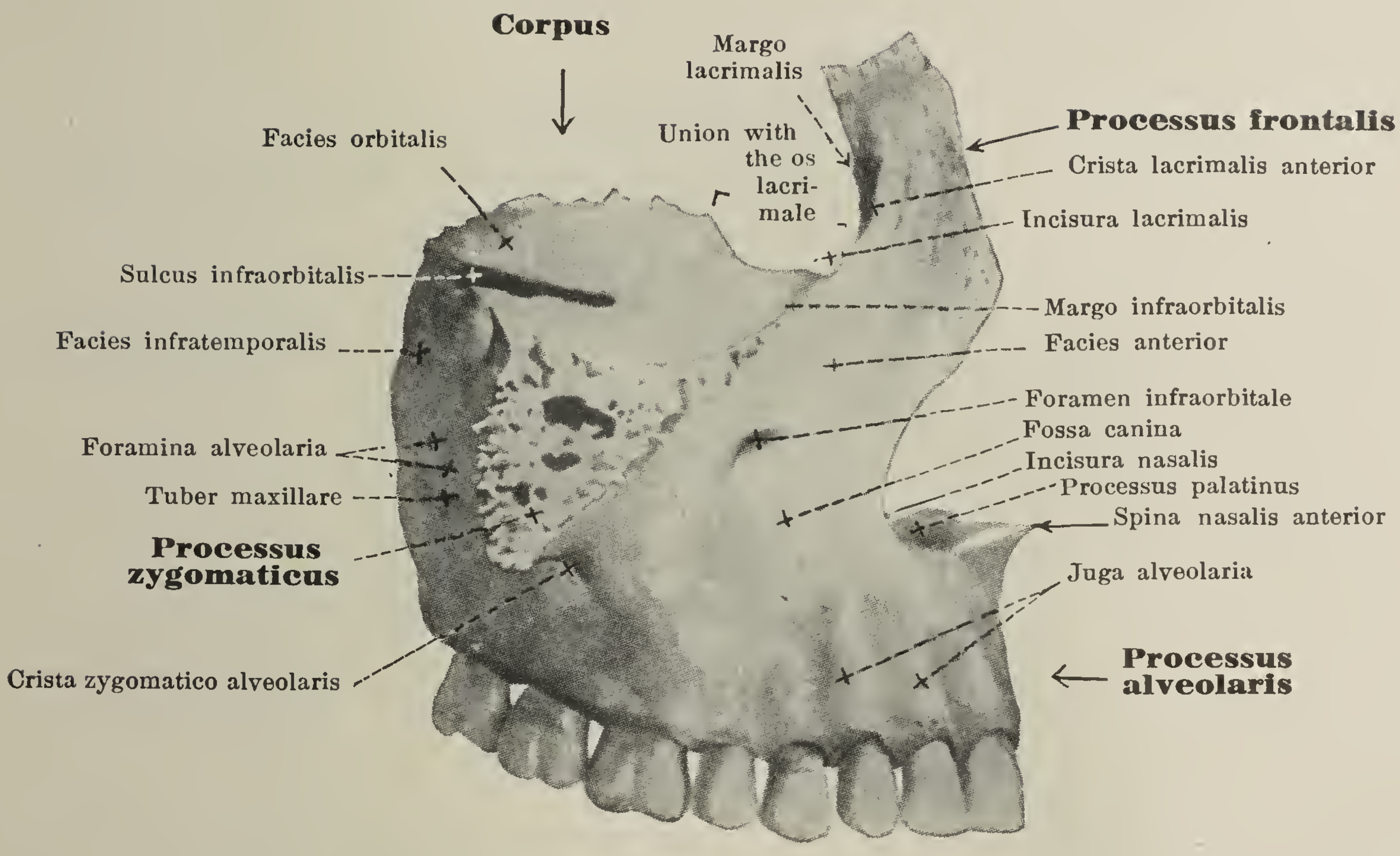
The **os nasale** *(nasal bone)* (see also Figs. 59, 60, 70, 76—78) is paired and forms with that of the other side the root of the nose and the upper part of the back of the nose. It is a small, oblong; quadrangular bone thicker and narrower above, thinner and broader below. The nasal bones of the two sides are attached to one another by their medial, slightly serrated borders to form the ***sutura internasalis;*** the upper serrated border unites with the margo nasalis of the pars nasalis oss. frontalis to form the ***sutura nasofrontalis;*** the lateral, somewhat bevelled margin forms with the anterior margin of the processus frontalis maxillae the ***sutura nasomaxillaris;*** the inferior, bevelled, irregularly serrated margin unites with the lateral nasal cartilage and projects somewhat in front of it (see Figs. 977 and 980); in the macerated skull, however, it lies free and helps to bound the apertura piriformis. The anterior surface is smooth and usually slightly curved like a saddle. The posterior surface in its upper portion is attached from in front to the spina frontalis oss. frontalis; in its lower portion it is smooth and helps to form the bony part of the anterior wall of the nasal cavity; there is seen also the ***sulcus ethmoidalis*** (O. T. groove for nasal nerve) (for the n. ethmoidalis anterior). The nasal bone is often perforated by one or several small openings, *foramina nasalia*, for blood-vessels. (For development see p. 69.)


Squama frontalis
Lamina perpendicularis ossis ethmoidalis
Corpus ossis sphenoidalis
Ala vomeris
Os nasale
Concha nasalis inferior
Groove for the attachment of the lamina perpendicularis ossis ethmoidalis and the cartilago nasi
Ala vomeris
Lamina medialis processus pterygoidei ossis sphenoidalis
Vomer
Processus palatinus maxillae

34 and 35. Ploughshare bone, *vomer,*

from the left. from in front.

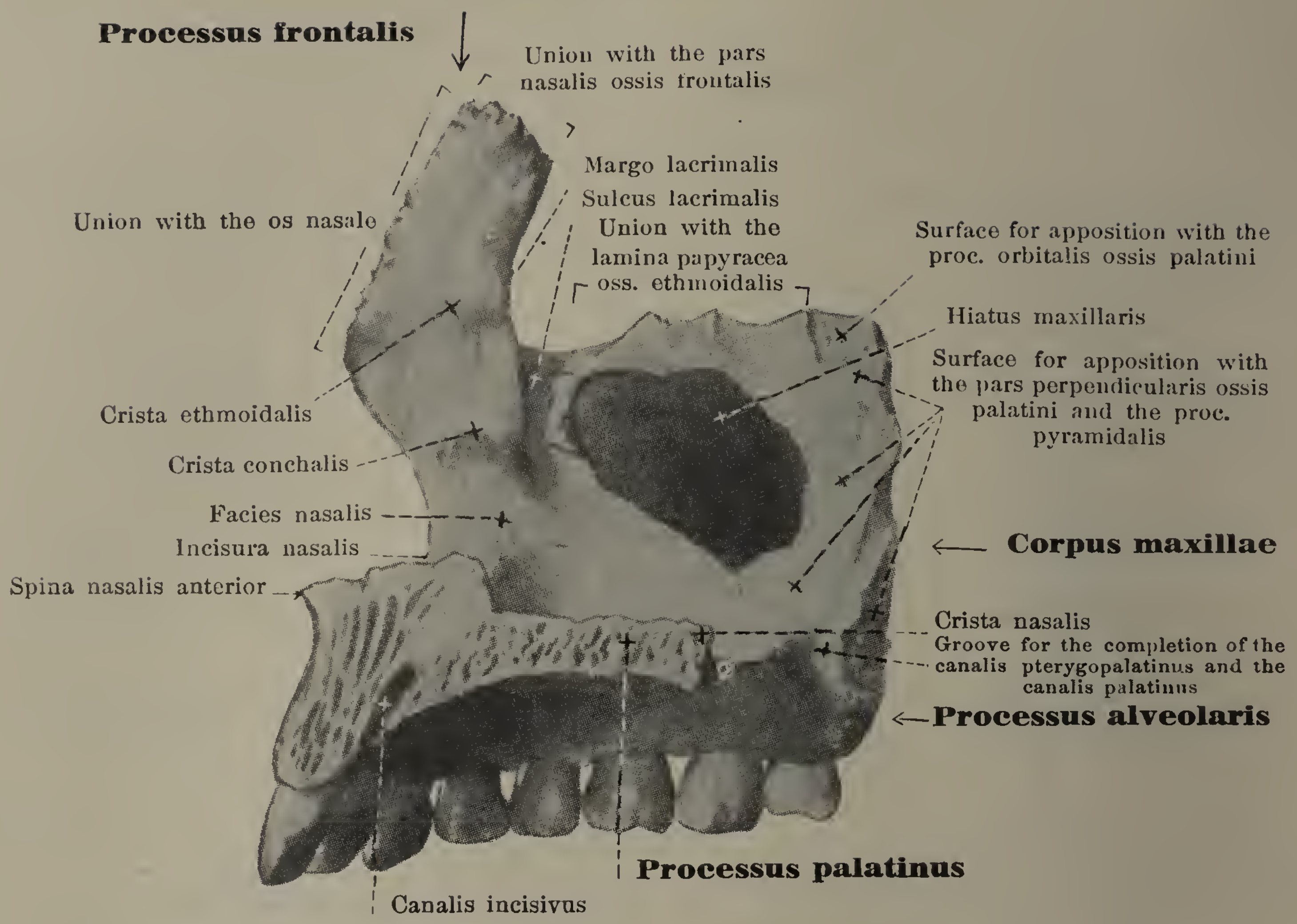
The **vomer** *(ploughshare bone)* (see also Figs. 78 and 979) is an unpaired, oblong quadrangular, flat bone which lies in the median plane and forms the posterior part of the nasal septum. It is usually bent somewhat to one side, but never at its posterior margin. Its upper margin is broad and is split into two thick laterally directed leaves *(alae vomeris)*, each of which is attached by its free margin to the proc. vaginalis of the proc. pterygoideus oss. sphenoidalis and to the proc. sphenoidalis oss. palatini. These two wings of the vomer leave a groove between them in which is placed the rostrum sphenoidale. The posterior margin is smooth, thin and lies free. The inferior margin is sharp and serrated, and adjoins the crista nasalis of the united palate bones and upper jaw bones. The anterior margin, which is also the upper, is somewhat thickened and hollowed out to form a groove; it unites behind with the inferior margin of the perpendicular plate of the ethmoid bone, in front with the cartilaginous nasal septum (see Fig. 979). (For development see p. 70.)



36. Right upper jaw bone, *maxilla,* from without.

The **maxilla** (O. T. superior maxillary bone) (see also Figs. 37, 38, 57—62, 69—78) is paired, lies in the upper anterior part of the facial skull and is divisible into a *corpus* or body and four processes of which two, the *processus frontalis* and *processus zygomaticus* belong to the upper part, while the two others, the *processus alveolaris* and the *processus palatinus*, belong to the lower part. (For development see p. 70.)

The ***corpus*** or *body* (see also Figs. 37, 38, 57—60 and 69—75) is quadrangular in shape and contains within it a large cavity, *sinus maxillaris* (see also Fig. 567) (O. T. antrum of Highmore), lined by mucous membrane, the entrance to which, *hiatus maxillaris* (see also p. 30), is situated on the nasal surface. The upper surface, *facies orbitalis (planum orbitale)*, is smooth, triangular, directed obliquely forward, outward and downward and forms the floor of the orbit; its medial border unites behind with the lamina papyracea oss. ethmoid. *(sutura ethmoideomaxillaris)*, in front with the lachrymal bone *(sutura lacrimomaxillaris)*; the anterior border is smooth medianward, lying free as the *margo infraorbitalis*, while lateralward it is serrated and goes over into the proc. zygomaticus; the posterior border is for the most part smooth, lies free, and forms with the inferior margin of the orbital surface of the large wing of the sphenoid running approximately parallel to it, the *fissura orbitalis inferior* (for the a. infraorbit.; v. ophthalm. inf.; nn. zygomat., infraorbit.). From this point forward on the upper surface extends a groove *(sulcus infraorbitalis)* closed by periosteum, which gradually becomes deeper and is continued into the *canalis infraorbitalis* (both for the a. infraorbit.; n. infraorbit.); branching off from this are the very minute *canales alveolares* (for the aa. alveol. sup. ant.; rr. alveol. sup. medius et anteriores n. infraorbit.), which run within the anterior wall of the body of the bone. Upon and beneath the posterior medial angle of the facies orbitalis is attached the proc. orbital. oss. palat. *(sutura palatomaxillaris)*. The posterior surface *facies infratemporalis* (O. T. zygomatic surface) looks into the fossa infratemporalis and pterygopalatina, is slightly rough, often bulged out *(tuber maxillare)* and there gives origin to parts of the mm. pterygoidei; it presents from two to three small openings, *foramina alveolaria*, which lead into canals passing forward, the *canales alveolares* (O. T. posterior dental canals) for the a. alveol. sup. post.; nn. alveol. sup.) which run forward in the lateral wall and are connected with the anterior canales alveolares. The anterior surface, *facies anterior* (O. T. external or facial surface), presents above the *foramen infraorbitale*, the opening of exit of the canalis infraorbit.; beneath it a variable depression, *fossa canina* (for the m. caninus). There arise also in front several muscles, the caput infraorbit. m. quadrat. labii sup., m. nasalis, m. incisivus, m. buccinat. Medianward the facies anterior runs out into a sharp margin, the *incisura nasalis*, which partly limits the *apertura piriformis.*

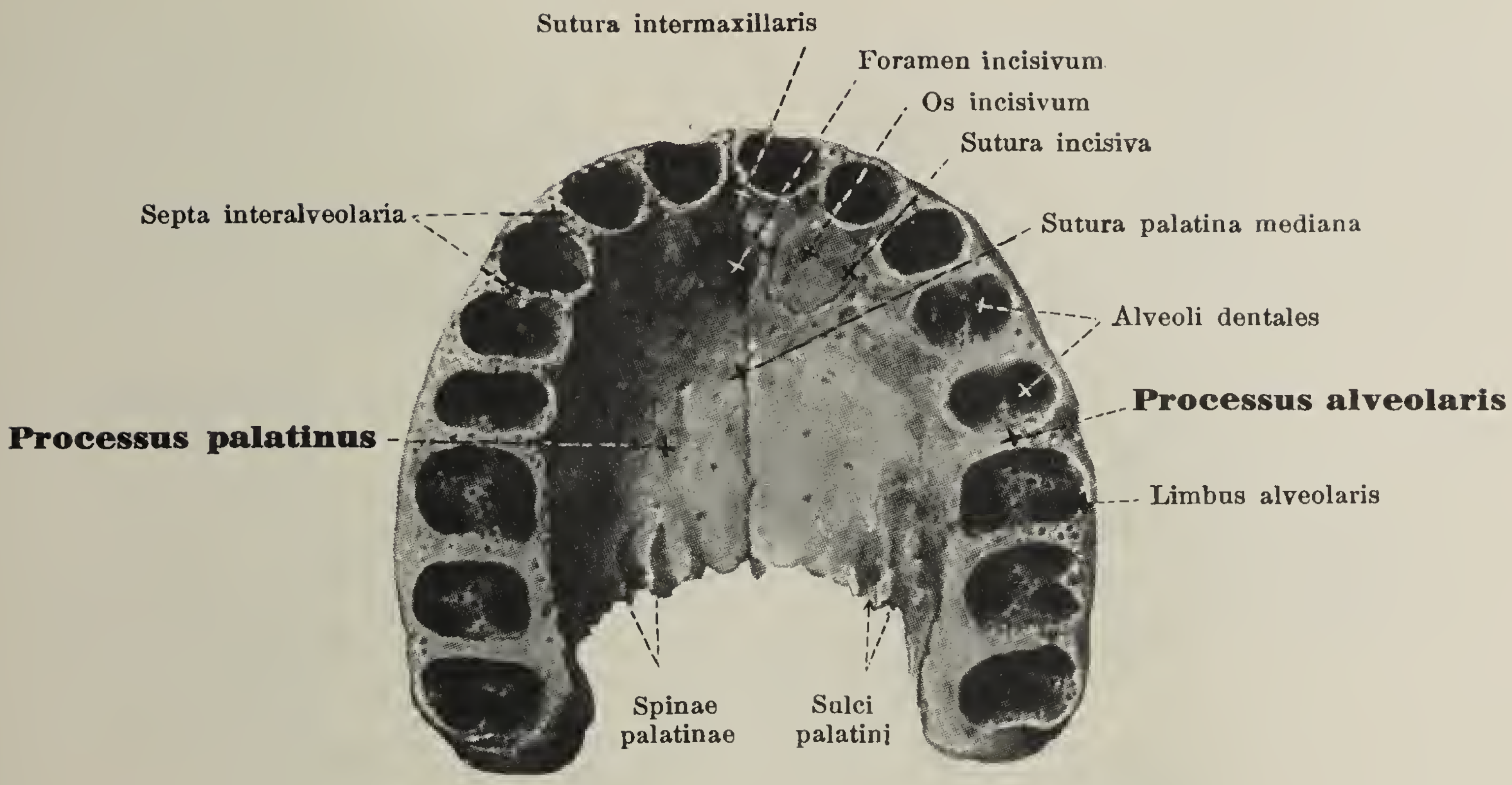

Processus frontalis
Union with the pars nasalis ossis frontalis
Margo lacrimalis
Sulcus lacrimalis
Union with the lamina papyracea oss. ethmoidalis
Union with the os nasale
Surface for apposition with the proc. orbitalis ossis palatini
Hiatus maxillaris
Surface for apposition with the pars perpendicularis ossis palatini and the proc. pyramidalis
Crista ethmoidalis
Crista conchalis
Facies nasalis
Incisura nasalis
Spina nasalis anterior
Corpus maxillae
Crista nasalis
Groove for the completion of the canalis pterygopalatinus and the canalis palatinus
Processus alveolaris
Processus palatinus
Canalis incisivus

37. Right upper jaw bone, ***maxilla,*** from within.

The *facies nasalis* of the ***corpus*** **maxillae** (see also Figs. 76 and 77) is placed sagittally and helps to form the lateral wall of the nasal cavity. A large opening in it, the ***hiatus maxillaris***, leads into the *sinus maxillaris* (O. T. antrum of Highmore) (see also p. 63). The slightly rough field behind the hiatus has attached to it the facies maxillaris of the pars perpendicularis oss. palatini and presents usually a smooth, almost perpendicular groove for the completion of the canalis pterygopalatinus, occasionally also of the canalis palatinus; the area behind this groove serves for apposition with the proc. pyramidalis oss. palatini. In front of the hiatus in the upper part passing downward from the posterior margin of the proc. frontalis is the *sulcus lacrimalis* which is closed to form the *canalis nasolacrimalis* (O. T. lachrymal groove) by the attachment to it medianward of the os lacrimale above and the proc. lacrimalis conchae nasalis inferioris below (see Figs. 29 and 31). In front of this the *crista conchalis* (for union with the upper border of the concha nasalis inferior) runs approximately horizontally forward. The anterior margin, *incisura nasalis*, helps to bound the *apertura piriformis.*

The ***sinus maxillaris*** *(upper maxillary cavity)* (see also p. 29 and Figs. 70, 75, 568, 580 and 823) presents approximately the form of a tetrahedron. It runs with the exception of the place of the canalis infraorbitalis almost everywhere nearly as far as the free surface of the body. In front it terminates in a groove, which runs from the centre of the beginning of the proc. frontalis downwards, and farther over the alveoli of the canine tooth as well as the premolar and molar teeth in a curve backwards (see Fig. 580). This groove does not usually project more deeply than to the base of the nasal cavity (see Fig. 568) and has its lowest point by the 2nd premolar or 1st molar tooth, and is separated from the apex of the alveoli of the four back teeth only by a thin layer of bone. The sinus may reach farther into the proc. alveolaris in the case of enlargement, and run into the proc. zygomaticus and proc. palatinus; it may also project over the facies infratemporalis and facies anterior (formation of a tuber maxillare and touching of the fossa canina).

The ***processus frontalis*** (O. T. *nasal process)* (see also Figs. 36, 57—60, 69—72, 76 and 77) ascends in front from the upper margin of the facies nasalis and facies anterior. Its upper, thick, serrated margin lies upon the pars nasalis oss. frontalis *(sutura frontomaxillaris)*; the anterior, sharp, slightly serrated margin unites with the os nasale (*sutura nasomaxillaris).* The posterior broad margin presents a groove, *sulcus lacrimalis*, which leads downward on the facies nasalis of the body (vide supra); it is bounded medianward by the *margo lacrimalis,* to which is attached the anterior margin of the lachrymal bone *(sutura lacrimomaxillaris);* lateralward by the slight *crista lacrimalis anterior,* which goes over into the margo infraorbitalis; behind this point of transition or as an interruption of the margo is situated the *incisura lacrimalis*, of variable depth, in which is placed the hamulus lacrimalis oss. lacrimalis. The lateral surface is smooth; on the medial, running from behind forward, is the *crista ethmoidalis* (for apposition with the anterior extremity of the medial surface of the labyrinth).

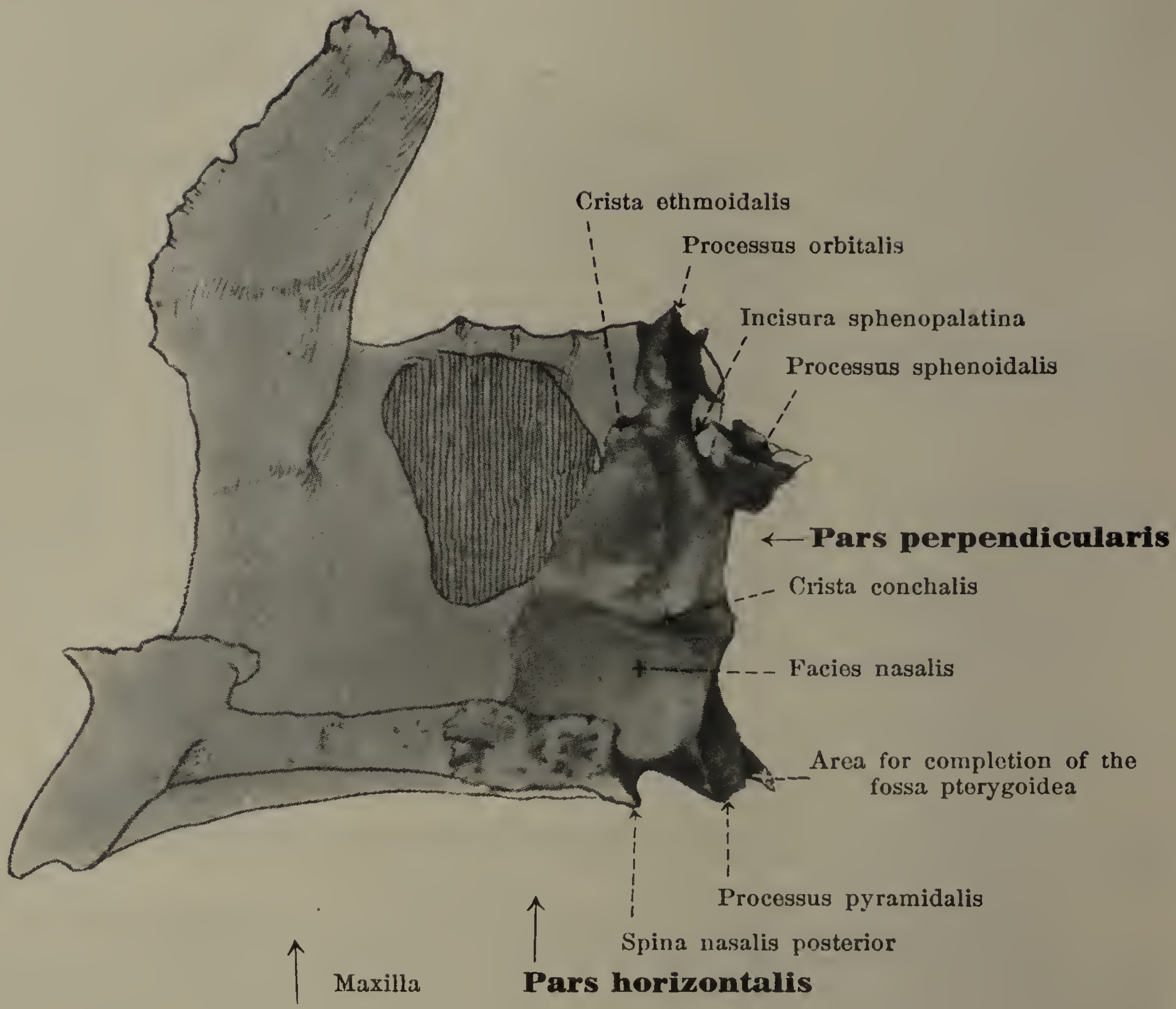


38. The two upper jaw bones, *maxillae,* united, from below.

The short, broad ***processus zygomaticus*** (O. T. *malar process)* (see also Figs. 36, 59, 60 and 71—74) proceeds from the lateral upper angle of the body of the upper jaw and is generally hollowed out inside for a bulging of the sinus maxillaris. Its surface is rough, sometimes incomplete, namely when the sinus maxillaris extends to the os zygomaticum, and unites with the os zygomaticum to form the *sutura zygomaticomaxillaris.*

The ***processus palatinus*** (see also Figs. 37, 61, 62, 76—78 and 567) is a transversely placed plate of bone which goes off medianward from the inferior margin of the facies nasalis and helps to form the bony septum between the nasal and the buccal cavity. At the medial, widened rough margin the two maxillae unite with one another to form the *sutura palatina mediana;* above the same on each maxilla runs a ridge, *crista nasalis,* the union of the two ridges serving for the attachment of the vomer and the cartilage of the septum of the nose (see also Fig. 979). The posterior margin lies on the anterior border of the pars horizontalis oss. palatini *(sutura palatina transversa).* The upper surface is smooth and slight concave in frontal direction; the inferior surface is rougher and presents near the posterior extremity usually two *sulci palatini* (for the branches of the a. palatina major) bounded by small ridges, *spinae palatinae.*

The ***processus alveolaris*** (see also Figs. 36, 37, 57—62, 67—70 and 567) is dependent in its development on that of the teeth and extends downward like an arch convex in front and externally, concave behind and internally, from the lower margin of the body; it forms together with the other maxilla a half elliptical arch. The broader, free, inferior margin, *limbus alveolaris,* contains eight tooth-cavities, *alveoli dentales,* which are separated from one another by the *septa interalveolaria;* they have wide mouths and grow narrower in the depth; they are exact impressions of the corresponding roots of the teeth. The anterior surface of the proc. alveolaris presents oblong projections, *juga alveolaria,* corresponding to the anterior five alveoli. The portion of the bone lying most medianward including the most anterior two (incisor-teeth) alveoli represents what is in the fetus a special bone *(os incisivum)* (see also p. 70) which fuses early with the rest of the bone; remains of the suture originally present at the site of union, the *sutura incisiva,* are usually distinct in the newborn, sometimes also in the adult; medianward they extend, arch-like, backward to an unpaired opening, *foramen incisivum,* situated on the inferior surface of the combined proc. palatini; from it proceeds upward the symmetrically forking *canalis incisivus* (for branches of the a. palatina major, branches of the n. nasopalatinus) and ends on the upper surface of each proc. palatinus by an opening on each side. The two processus alveolares unite in the median plane by the *sutura intermaxillaris,* the anterior continuation of the sutura palatina mediana; above this suture there is continued forward on each upper jaw, the *crista nasalis (nasal crest);* it is higher in the region of the sutura intermaxillaris than it is behind and ends behind in the vomer and in front in a projection, the *spina nasalis anterior.*

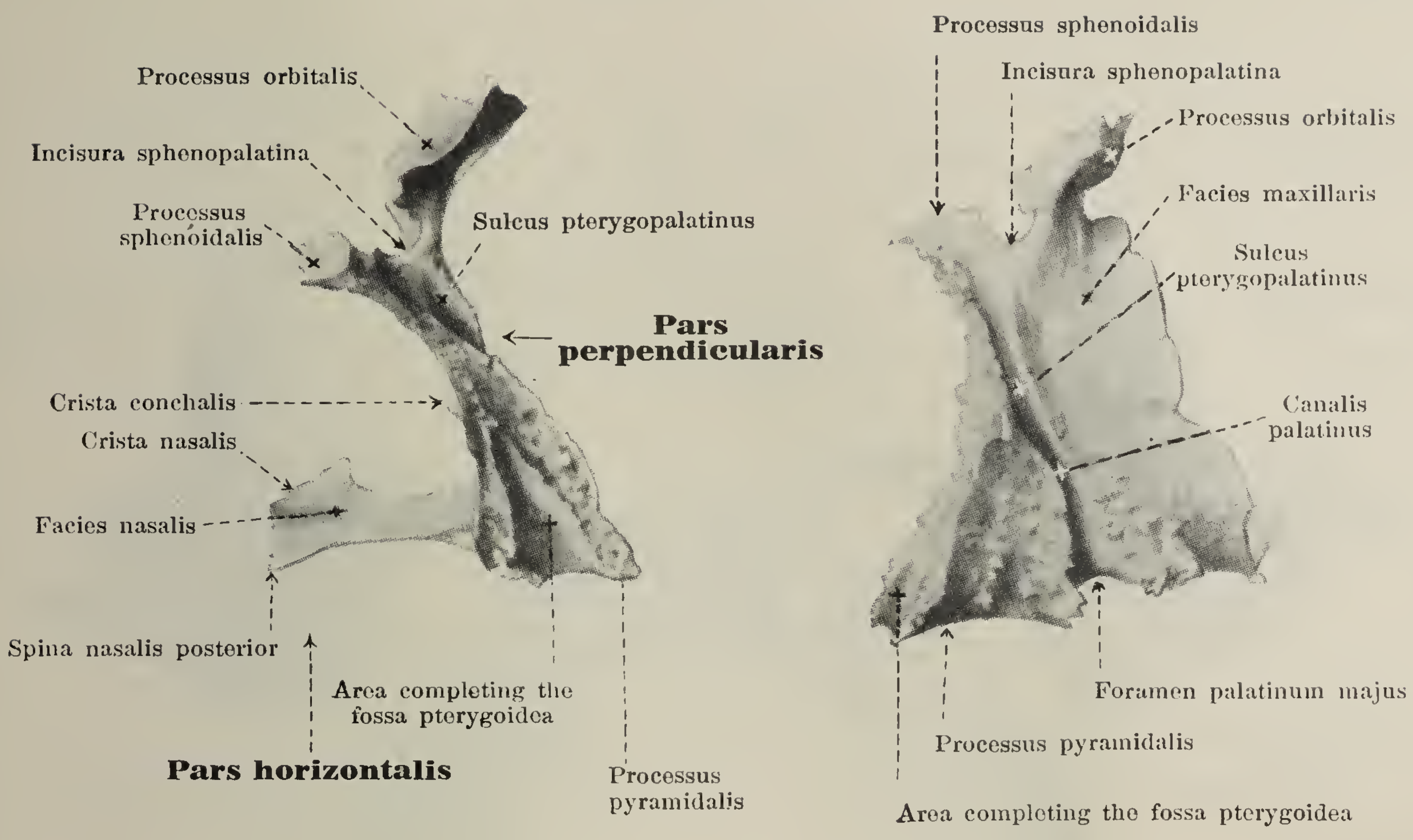


39. Right palate bone, *os palatinum,* from within.

The paired **os palatinum** *(palate bone)* (see also Figs. 40, 41, 61, 62, 70—72 and 74—77) lies in the posterior part of the nasal cavity and there forms a part of the partition wall between nasal cavity and mouth cavity (of the hard palate) and of the lateral wall of the nasal cavity. It presents for examination a *pars horizontalis* and a *park perpendicularis.* (For development see p. 70.)

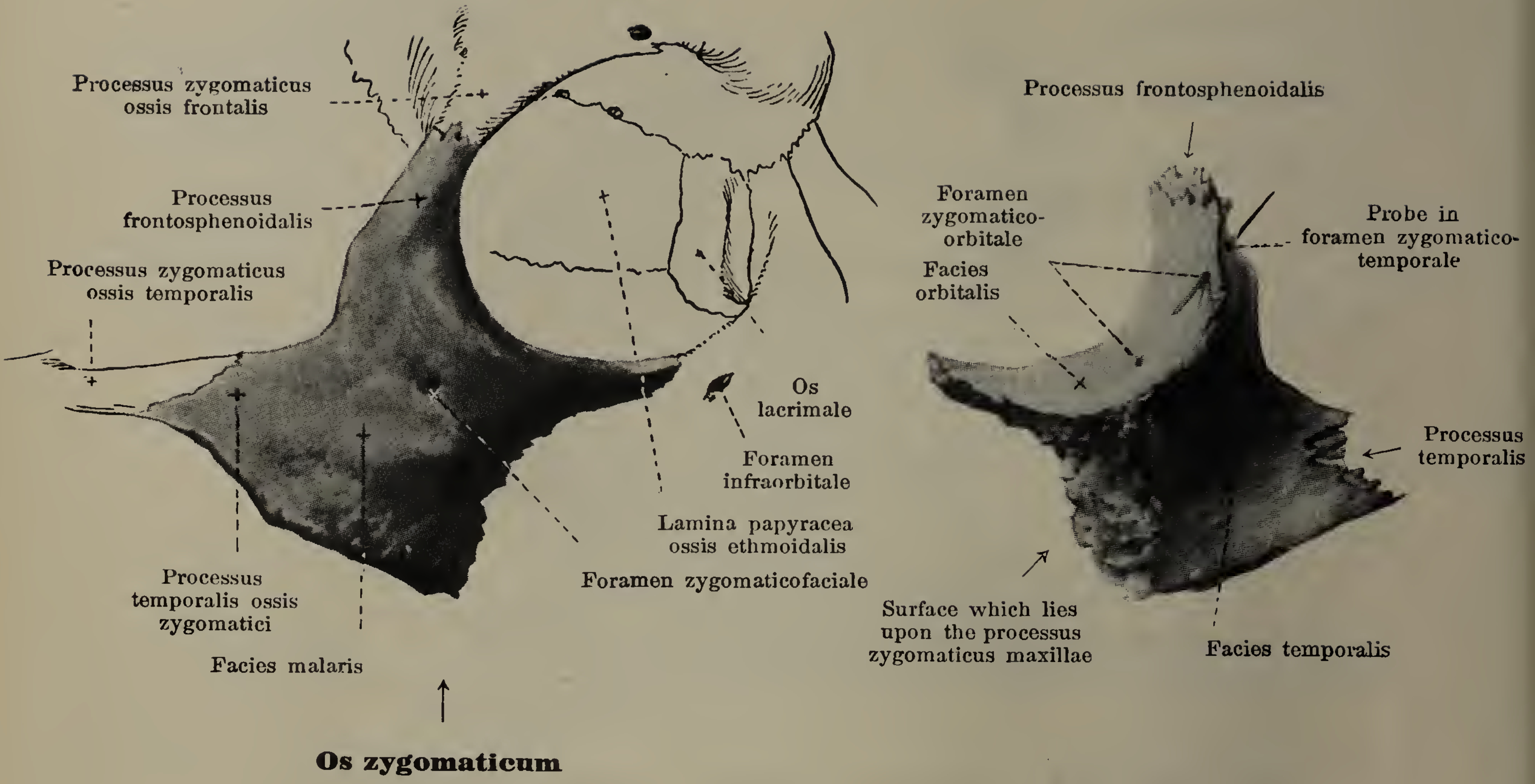
The ***pars horizontalis*** (O. T. *horizontal plate)* (see also Figs. 40, 61, 62 and 76—78) is very similar to the proc. palatinus maxillae, only shorter; the upper surface *(facies nasalis),* is smooth and slightly concave; the lower surface *(facies palatina)* (see Figs. 61 and 62) is somewhat rough and presents near the posterior margin a small sickle-shaped elevated surface for the attachment of the m. tensor veli palatini. The anterior, slightly serrated margin lies on the posterior border of the proc. palatinus maxillae and forms with this the *sutura palatina transversa.* The medial margin unites with the corresponding border of the bone of the other side and forms the posterior part of the *sutura palatina mediana;* on the upper surface of this border the *crista nasalis* (for union with the vomer) projects upward and runs out behind into the *spina nasalis posterior.* The posterior margin is smooth and concave.

From the lateral part of the posterior margin projects backward the strong *processus pyramidalis* having the form of a small three-sided pyramid (see also Figs. 40, 41, 61, 62, 69 and 70). It is more or less inserted in front into the fissura pterygoidea oss. sphenoidalis, so that its posterior surface with a smooth area helps to complete the lower part of the fossa pterygoidea; on each side of this smooth area, the posterior surface is rough and is united with the proc. pterygoideus. The external anterior, rough surface unites with the posterior portion of the corpus maxillae just above the eighth alveolus. The edge between the posterior and the lateral surface sometimes helps also to form the fossa infratemporalis (see Fig. 70), and then possesses a smooth surface. The medial, smooth surface looks into the nasal cavity. The inferior surface (base of the pyramid) belongs to the lower surface of the hard palate and contains usually three openings, of which the *foramen palatinum majus* lies furthest forward, the others, *foramina palatina minora,* lie further backward (see Fig. 61). These are the outlets of the sulci palatini on the hard palate (see p. 31), and also the openings of the canales palatini (for the aa. palatinae major et minores; nn. palatini); they usually pierce the proc. pyramidalis perpendicularly, but occasionally, especially the longest of them, run between the plate and the upper jaw, so that there is a corresponding groove on each of the bones.



40 and 41. Right palate bone, *os palatinum,*
from behind, from without.

The **pars perpendicularis** (O.T. *vertical plate)* (see also Figs. 39, 70—72 and 74—77) ascends as a thin leaf of bone vertically upward from the lateral margin of the pars horizontalis. The medial *facies nasalis* is smooth and presents two ridges extending from before backward, an upper, shorter, *crista ethmoidalis* (O. T. superior turbinated crest), for the attachment of the posterior, free end of the concha nasalis media, and a lower, *crista conchalis* (O. T. inferior turbinated crest), for union with the concha nasalis inferior (see Fig. 77). The lateral surface, *facies maxillaris,* is for the most part rough and unites in front with the posterior, rough portion of the facies nasalis corporis maxillae, so that it covers over a portion of the hiatus maxillaris from behind (see Fig. 70); it is attached behind to the anterior margin and the medial surface of the lamina medialis proc. pterygoidei oss. sphenoidalis. Between these two areas, extending from above downwards, is the smooth, shallow *sulcus pterygopalatinus.* Through the attachment of the lateral surface to the two bones mentioned this forms together with the sulcus pterygopalat. of the proc. pteryg. oss. sphenoidalis and a groove on the upper jaw bone, above, the *fossa pterygopalatina,* open lateralward (for the aa. maxill. int., palat. descendens, sphenopalat.; nn. maxillaris, zygomat., sphenopalat., alveol. sup., infraorbit., rr. alveolares superiores posteriores gangl. sphenopalat.), below, the *canalis pterygopalatinus* (O. T. posterior palatine canal) (for the a. palat. descendens; nn. palat., rr. nasal. post. inf. gangl. sphenopalat.), closed also externally by the proc. pterygoideus oss. sphenoid. and the upper jaw; it is continued below into the *canales palatini* (see p. 32) (for the aa. palatinae major et minores; nn. palat.) which usually run in the proc. pyramidalis alone. From the upper margin of the pars perpendicularis extend two processes, the *processus sphenoidalis* bent somewhat backward and markedly medianward, which lies on the inferior surface of the body of the sphenoid and on the ala vomeris, and the *processus orbitalis* forward and somewhat lateralward. The latter is bulged out and contains a small cavity, the posterior part of a posterior ethmoidal cell which projects into the proc. orbitalis. Its lateral, upper, smooth surface forms the most posterior part of the floor of the orbit (see Fig. 70); in front and below it meets the facies orbitalis corporis maxillae *(sutura palatomaxillaris),* in front and above the lamina papyracea oss. ethmoid. *(sutura palatoethmoidalis),* behind and above the anterior margin of the lateral surface of the body of the sphenoid *(sutura sphenoorbitalis);* behind and below it lies free and helps in part to form the medial portion of the *fissura orbitalis inferior,* in part it looks into the fossa pterygopalatina. Between the proc. sphenoid. and the proc. orbital. lies the *incisura sphenopalatina,* which is closed by the attachment of the bone to the under surface of the body of the sphenoid forming the *foramen sphenopalatinum* (for the a. sphenopalat.; rr. nasal. poster. super. lateral et medial. gangl. sphenopalat.).

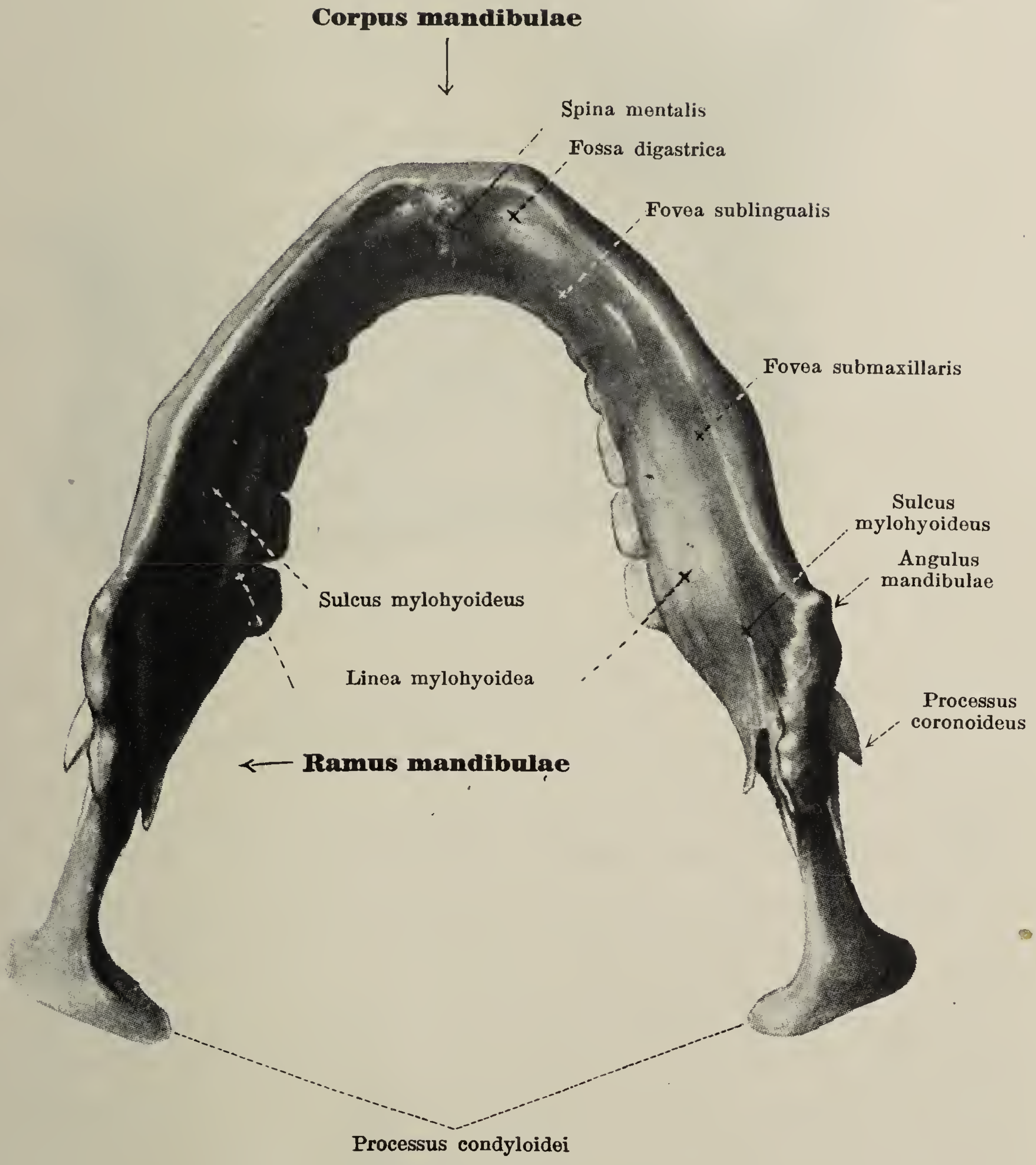

Processus zygomaticus ossis frontalis
Processus frontosphenoidalis
Processus zygomaticus ossis temporalis
Processus temporalis ossis zygomatici
Facies malaris
Os zygomaticum
Os lacrimale
Foramen infraorbitale
Lamina papyracea ossis ethmoidalis
Foramen zygomaticofaciale
Processus frontosphenoidalis
Foramen zygomatico-orbitale
Facies orbitalis
Probe in foramen zygomatico-temporale
Processus temporalis
Surface which lies upon the processus zygomaticus maxillae
Facies temporalis

42 and 43. Right yoke bone, *os zygomaticum,*

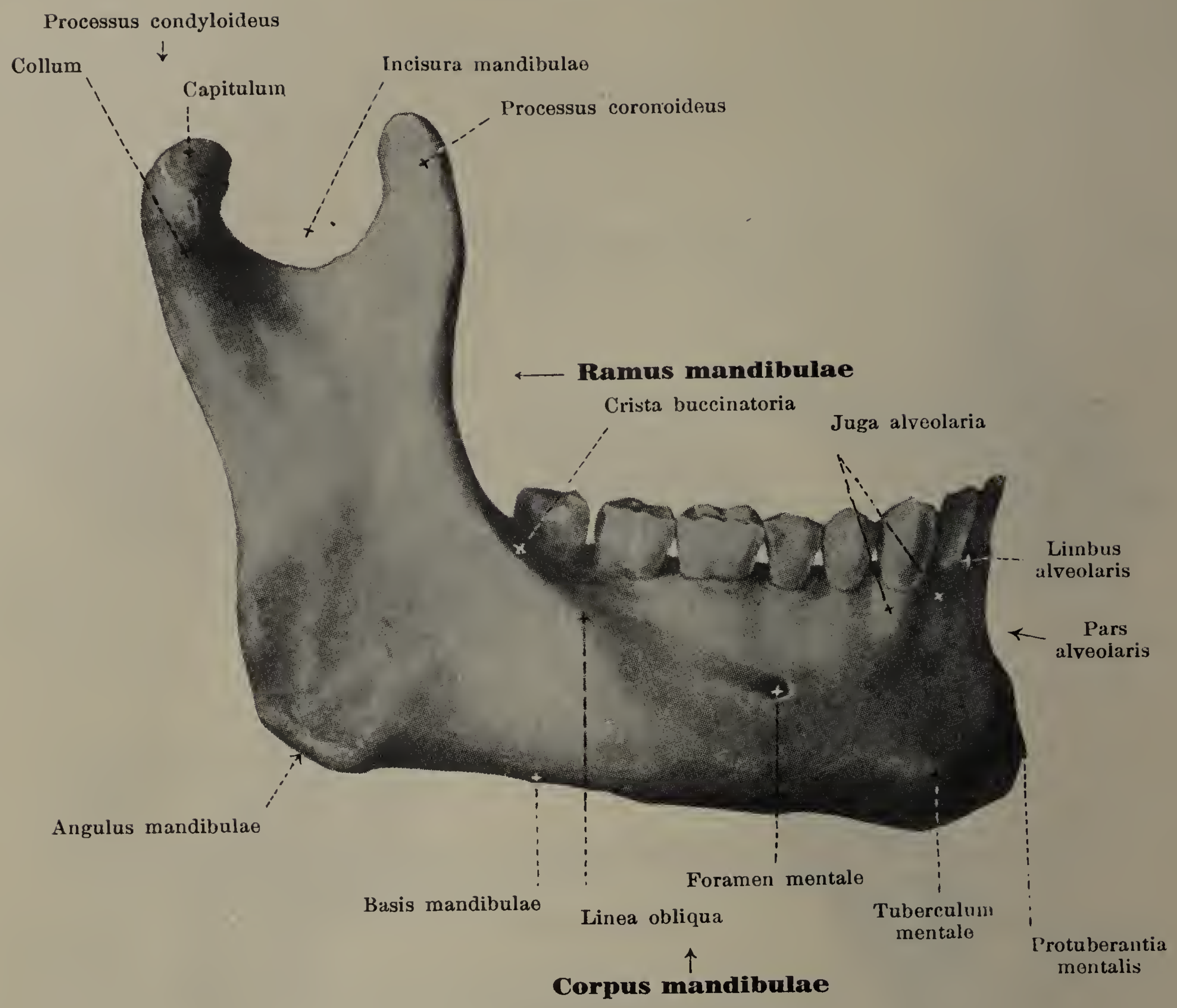
from without. from within.

The **os zygomaticum** or *yoke bone* (O. T. malar bone) (see also Figs. 57—62 and 71—74) is paired and lies in the lateral part of the facial skull. It has three surfaces. The laterally directed ***facies malaris*** is quadrangular, fairly smooth, markedly convex and presents the ***foramen zygomaticofaciale*** (O. T. malar foramen). The concave ***facies orbitalis***, directed medianward and forward, helps to form the lateral and inferior wall of the orbit and meets the facies malaris, forming a markedly curved concave margin, which below completes the ***margo infraorbitalis***, and above forms the lateral margin of the aditus orbitae. The medial inferior margin of the facies orbitalis unites with the lateral angle of the facies orbitalis corporis maxillae ***(sutura zygomaticomaxillaris)*** and forms in half the cases the lateral boundary of the fissura orbitalis inferior (see Figs. 73 and 74); the medial upper margin lies upon the margo zygomaticus of the ala magna oss. sphenoidalis ***(sutura sphenozygomatica)***. On the facies orbitalis can be seen the single or double ***foramen zygomaticoorbitale*** (O. T. temporo-malar canals), the entrance to a canal bifurcating in the bone (sometimes double from the beginning), the divisions of which perforate the bone and end on the facies malaris in the foramen zygomaticofaciale and the facies temporalis in the foramen zygomaticotemporale (for the r. zygomaticofacialis and r. zygomaticotemporalis n. zygomatici). The ***facies temporalis*** looks downward and medianward, is curved so as to be markedly concave and forms the anterior part of the fossa temporalis. Here the ***foramen zygomaticotemporale*** is visible medianward; it adjoins a rough surface for broad union with the proc. zygomaticus corporis maxillae ***(sutura zygomaticomaxillaris)***. Sometimes the sinus maxillaris extends to this surface; in that case it presents a smooth surface.

At the upper angle of the facies malaris lies the ***processus frontosphenoidalis*** (O. T. frontal process), in front for union with the proc. zygomaticus oss. frontalis ***(sutura zygomaticofrontalis)***, behind with the large wing of the sphenoid (vide supra). From the posterior angle of the bone goes off the slim ***processus temporalis*** (O. T. zygomatic process), which unites with the proc. zygomaticus oss. temporalis by a serrated suture ***(sutura zygomaticotemporalis)*** to form the ***arcus zygomaticus***. (For development see p. 70.)



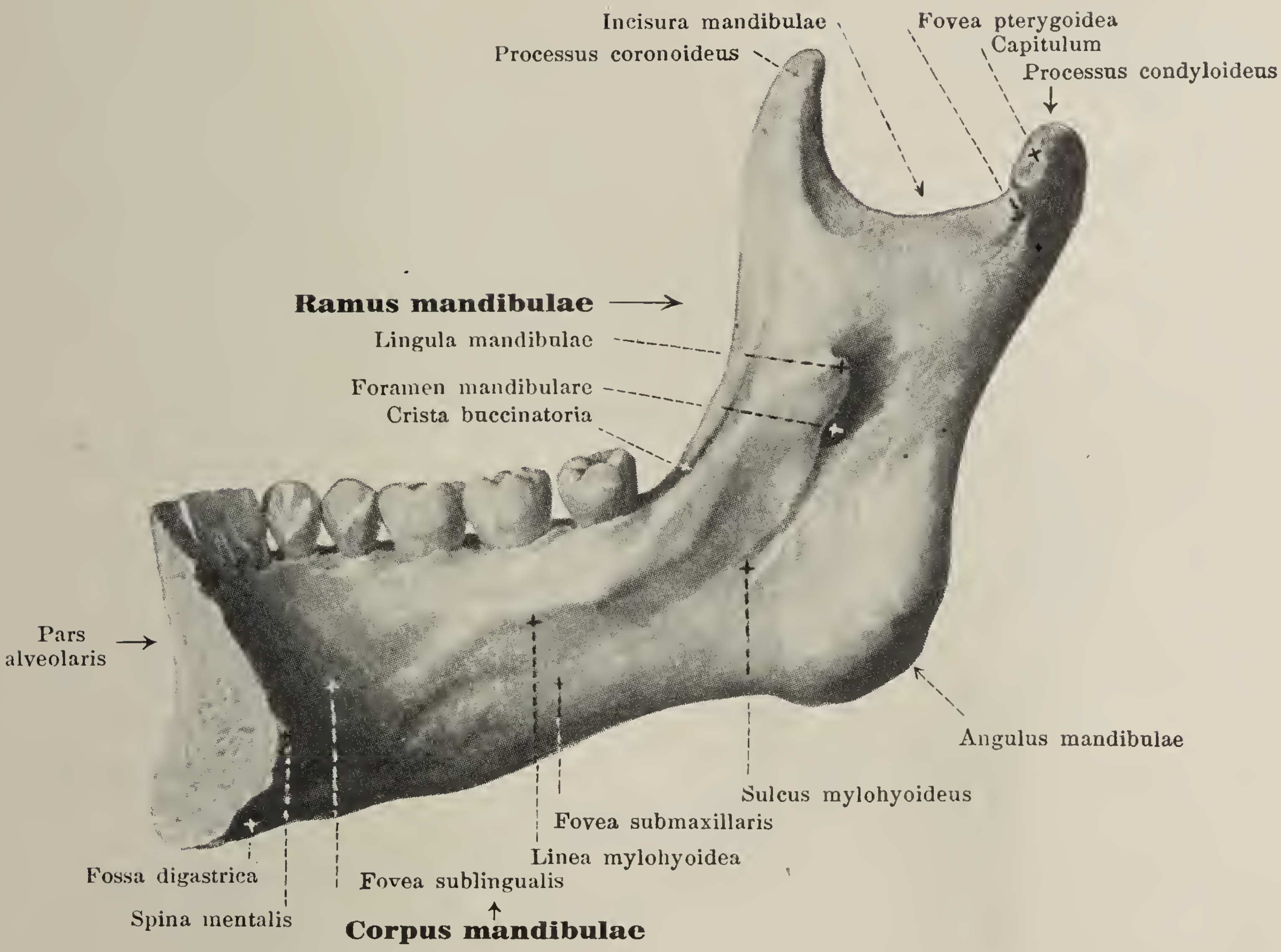
44. Lower jaw bone, *mandibula,* from below.



45. Lower jaw bone, ***mandibula,*** right half, from without.

The **mandibula** *(lower jaw bone)* (O. T. inferior maxillary) (see also Figs. 44, 46—52, 57—60, 67 and 68) is unpaired and forms the inferior anterior part of the facial skull. It consists of the parabolically curved *corpus*, and two *rami*, which ascend from the ends of the corpus. (For development see p. 70.)

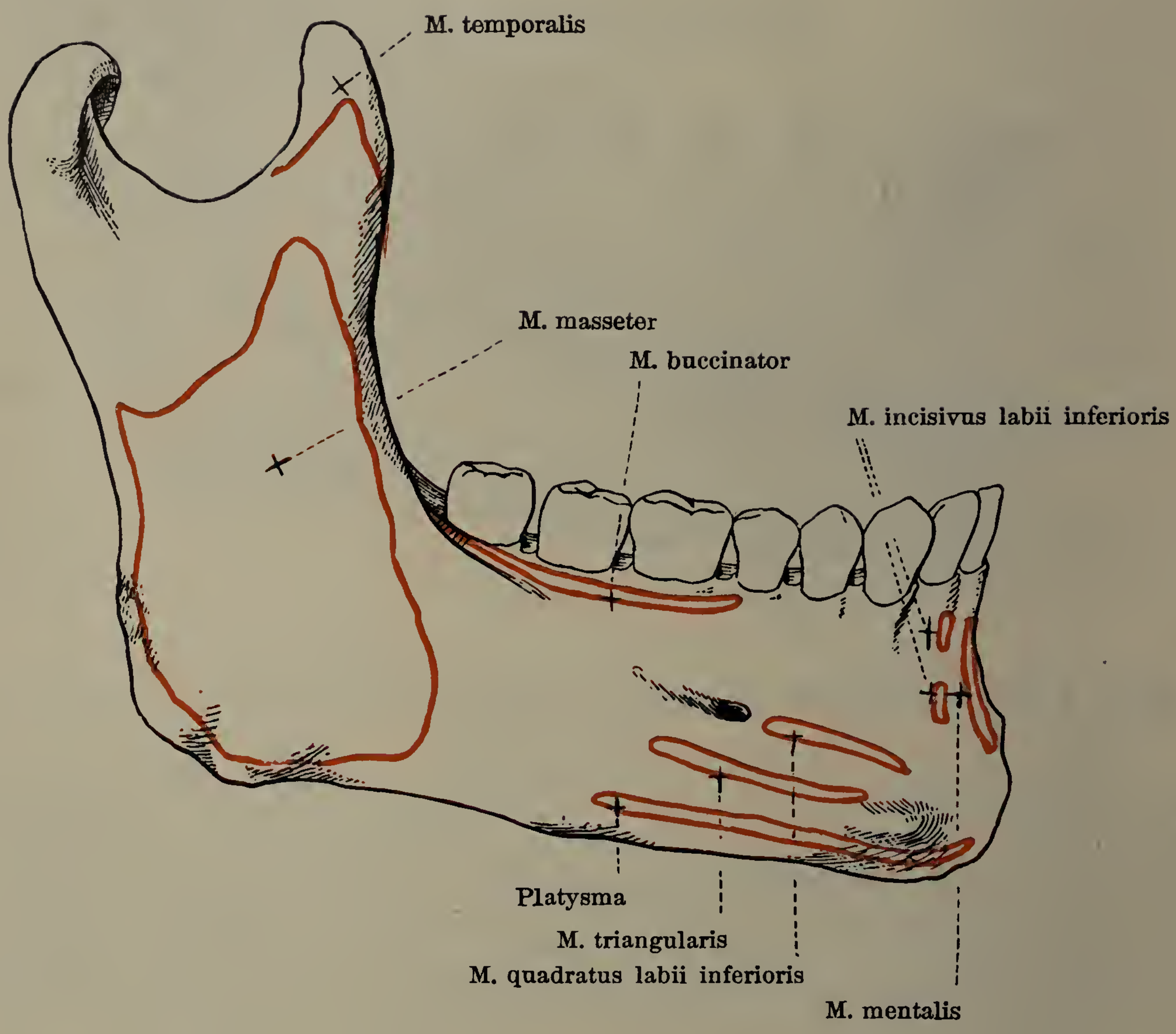
The ***corpus mandibulae*** *(body of lower jaw)* (see also Figs. 44, 46—52, 57—60, 67 and 68) consists originally of two halves united with one another in the median plane, the union taking place in the first or second year of life. The point of union is often indicated by a groove. Each half represents a mass of bone which is higher than it is thick, and curved in front so as to be markedly convex externally. Its inferior margin, *basis mandibulae*, is somewhat thickened and rounded; close above this, on the anterior surface near the median plane, is situated the somewhat roll-shaped, transversely placed *protuberantia mentalis* (O. T. mental process), which, lateralward, runs out into the *tuberculum mentale.* Somewhat lateralward and upward from the latter a round *foramen mentale* (for the a. mentalis; n. mentalis) is visible outside; it is usually situated below the alveolus of the second praemolar, about half-way between the base and the upper margin. Beneath it, or somewhat farther back, begins the *linea obliqua* (O. T. external oblique line) extending obliquely upward to the anterior margin of the ramus. The upper part of the body, *pars alveolaris*, dependent in development upon that of the teeth, is bounded above by a narrow border, the *limbus alveolaris.* It contains on each side eight, altogether then sixteen, *alveoli dentales* which are separated from one another by thin *septa interalveolaria;* the alveoli are wide at the opening and become narrower in the depth, being exact impressions of the roots of the teeth which they hold. Oblong projections, *juga alveolaria,* usually caused by the three anterior alveoli only, are observable on the outer surface. The medial surface of the corpus presents, close to the median plane, the single or double, short *spina mentalis* (O. T. genial tubercles) (for the mm geniohyoid., geniogloss.) and on each side below it, somewhat lateralward, the *fossa digastrica* (for the m. digastricus).



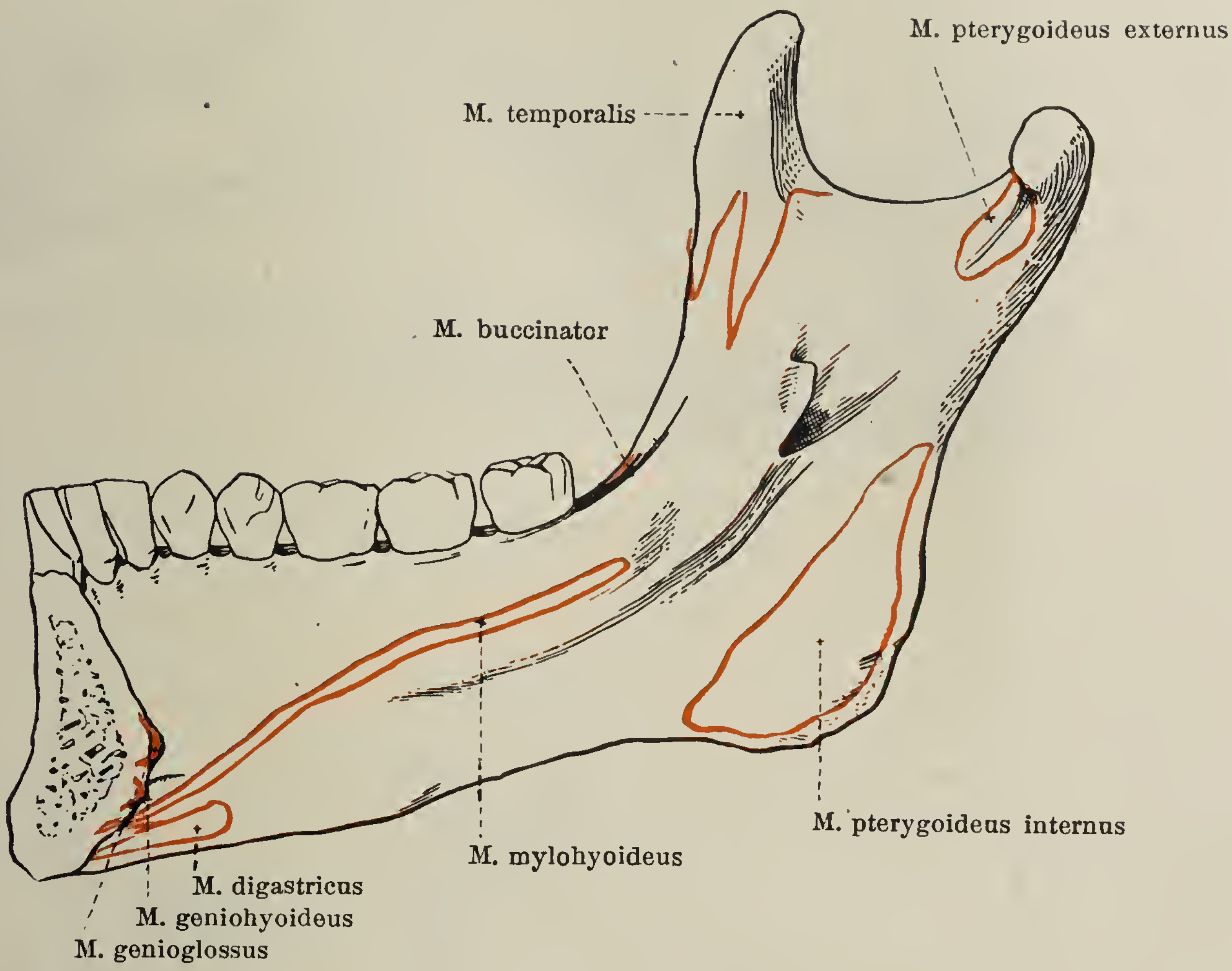
46. Lower jaw bone, *mandibula,* right half, from within.

Above the fossa digastrica on each side begins a slightly s-shaped, curved roller, the *linea mylohyoidea* (O. T. internal oblique line) (for the mm. mylohyoid., mylopharyng.), which ascends obliquely backward to the medial surface of the ramus. Above the medial part of the latter lies the *fovea sublingualis* (O. T. sublingual fossa) (for the gland. subling.), usually distinctly marked; beneath the lateral portion, often less well indicated, the *fovea submaxillaris* (O. T. submaxillary fossa) (for the gland. submax.). Extending forward and downward from the foramen mandibulare (see below), below the lateral part of the linea mylohyoidea, is the *sulcus mylohyoideus* (for the r. mylohyoid. a. alveol. inf.; n. mylohyoid.).

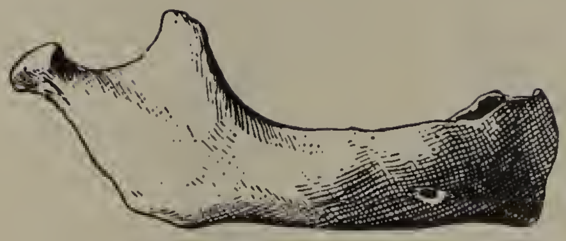
The ***ramus mandibulae*** (O. T. perpendicular portion) (see also Figs. 44, 45 and 57 to 60) is a broad plate of bone which extends from the posterior end of the body perpendicularly upward or obliquely backward. Its posterior, thicker margin forms with the basis corporis the *angulus mandibulae;* its anterior margin begins laterally at the posterior end of the linea obliqua, medianly at the last alveolus, with a small triangular surface on which is often visible the *crista buccinatoria* (for the m. buccinat.). The lateral surface is smooth, the medial presents about its middle an opening, *foramen mandibulare* (O. T. inferior dental foramen), which is bounded medianward by a small leaflet of bone, the *lingula mandibulae.* In the foramen mandibulare begins the *canalis mandibulae* (O. T. inferior dental canal) (for the a. alveol. inf.; n. alveol. inf.) which extends, within the spongiosa of the bone, arch-like, downward and forward as far as the alveolus of the medial incisor; it is wide as far as the foramen mentale through which it opens outwards; from there medianward it is narrow; at the foramen mandibulare the *sulcus mylohyoideus* (see above) also begins. The upper end of the ramus supports two processes separated from one another by the *incisura mandibulae* (O. T. sigmoid notch); the anterior, *processus coronoideus* (for the insertion of the m. temporal.), is bent and terminates in a blunt point backward somewhat hook-like; the posterior, *processus condyloideus,* which serves for articulation of the lower jaw with the rest of the skull, supports a roller-like *capitulum mandibulae,* covered over with fibrocartilage in its anterior division, the long axis of which converges with that of the other side backward toward the anterior circumference of the foramen occipit. magnum. The capitulum sits upon a narrower neck, *collum (proc. condyloidei) mandibulae,* and this presents in the medial part of its anterior surface the *fovea pterygoidea proc. condyloidei* (for the attachment of the m. pterygoid. ext.).



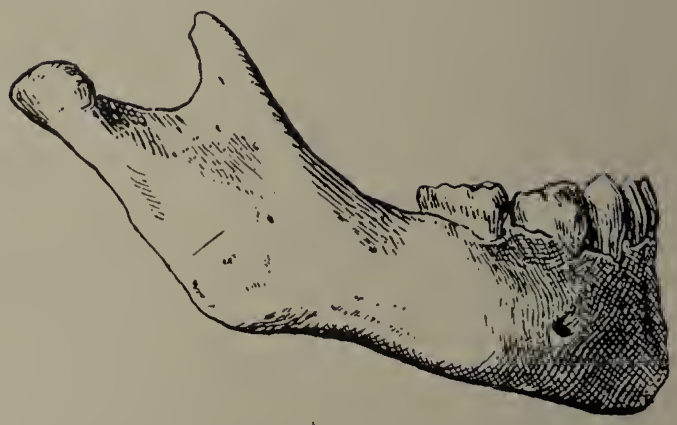
47. Lower jaw bone, ***mandibula,*** right half, from without, showing muscular attachments.



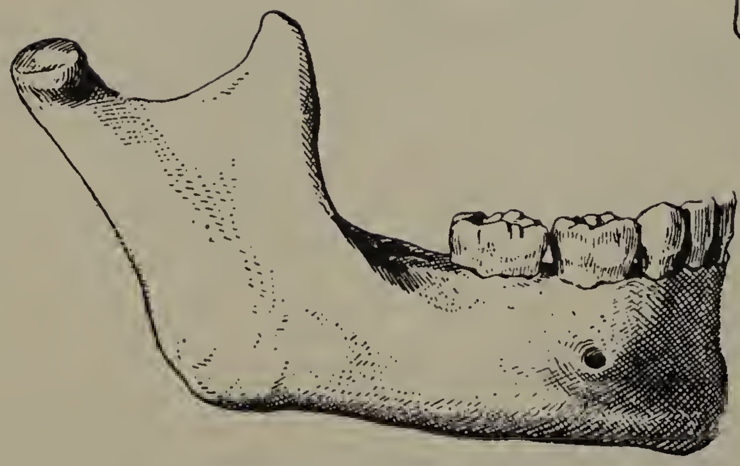
48. Lower jaw bone, ***mandibula,*** right half,
from within, showing muscular attachments.



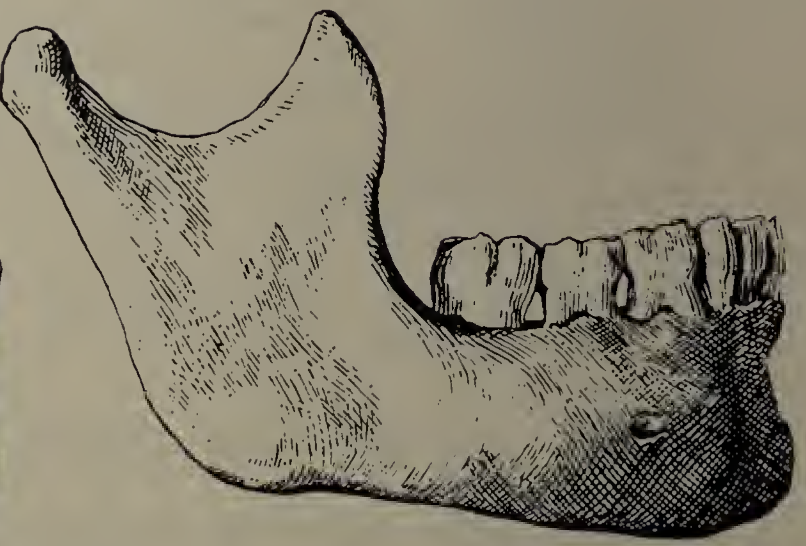
49. Newborn.



49 a. 3 years old child.



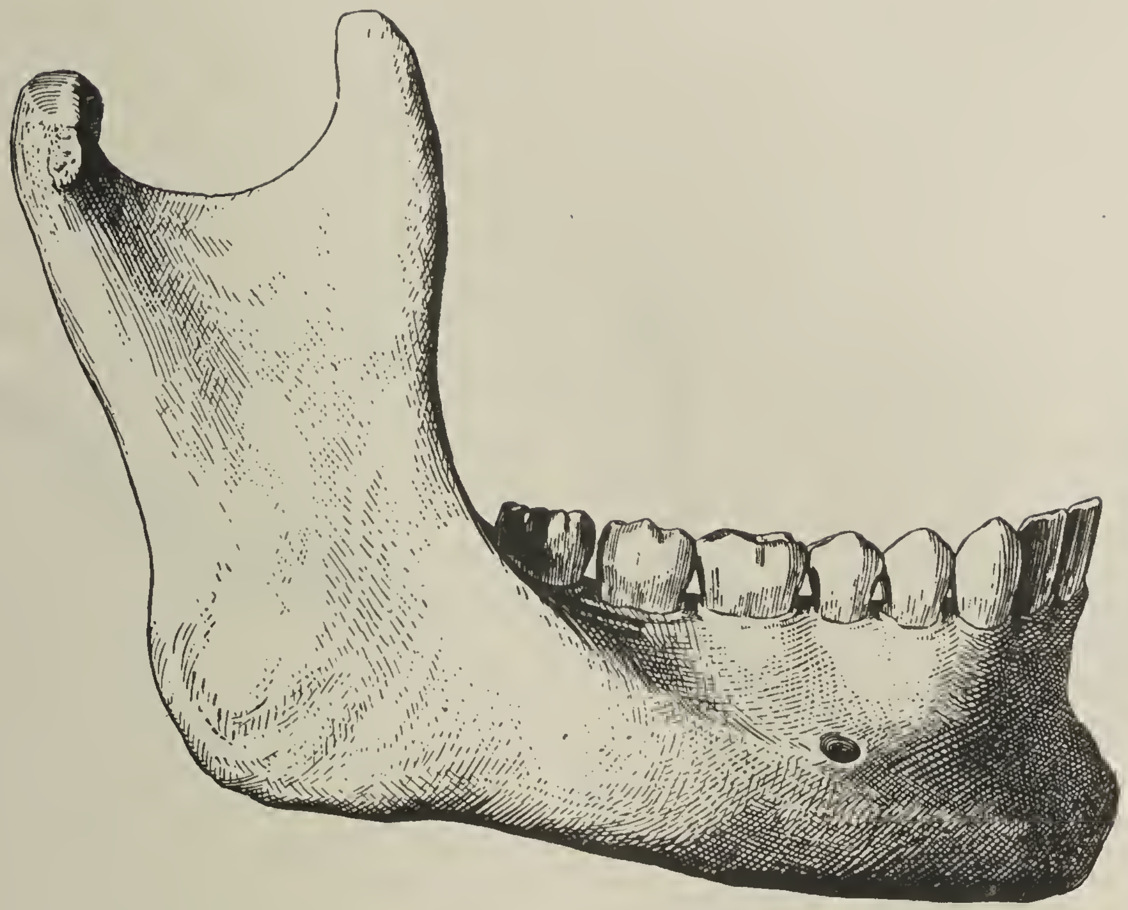
50. 6 years old child.



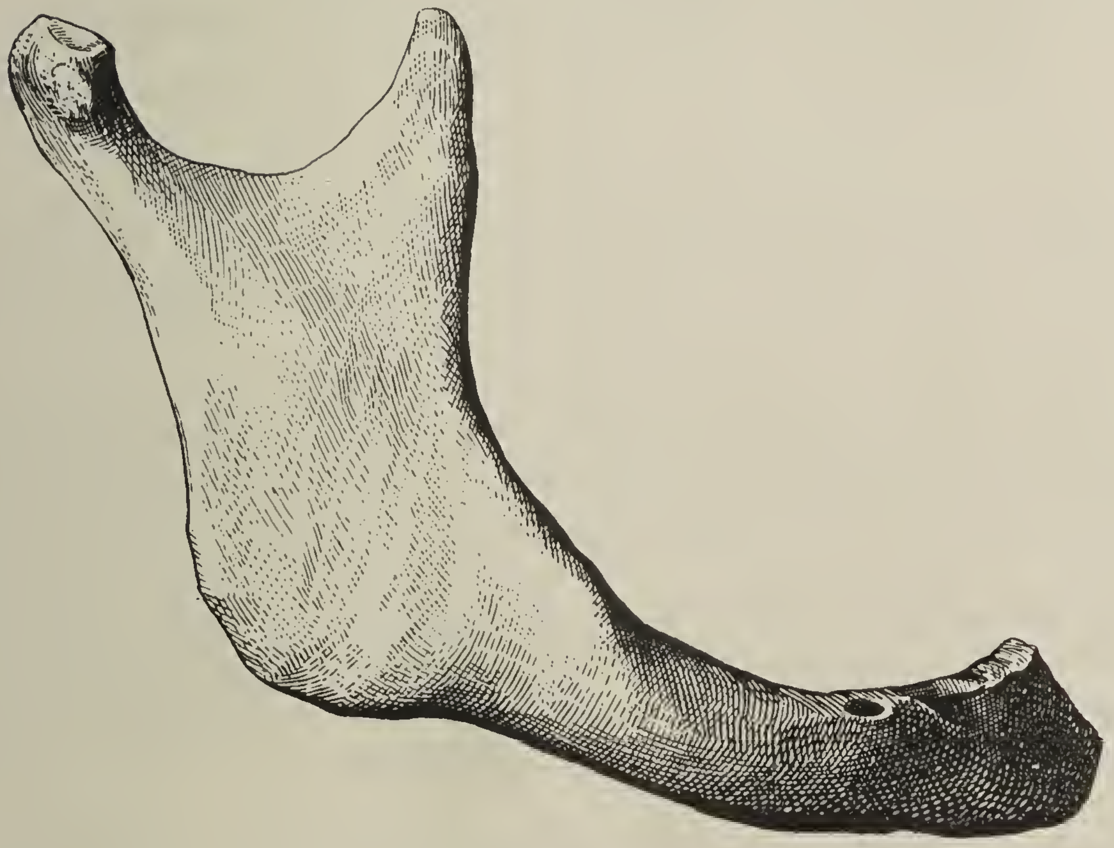
50 a. 8 years old child.

49—52. Lower jaw bones, ***mandibulae,***

at different ages of life, figures drawn to uniform scale.



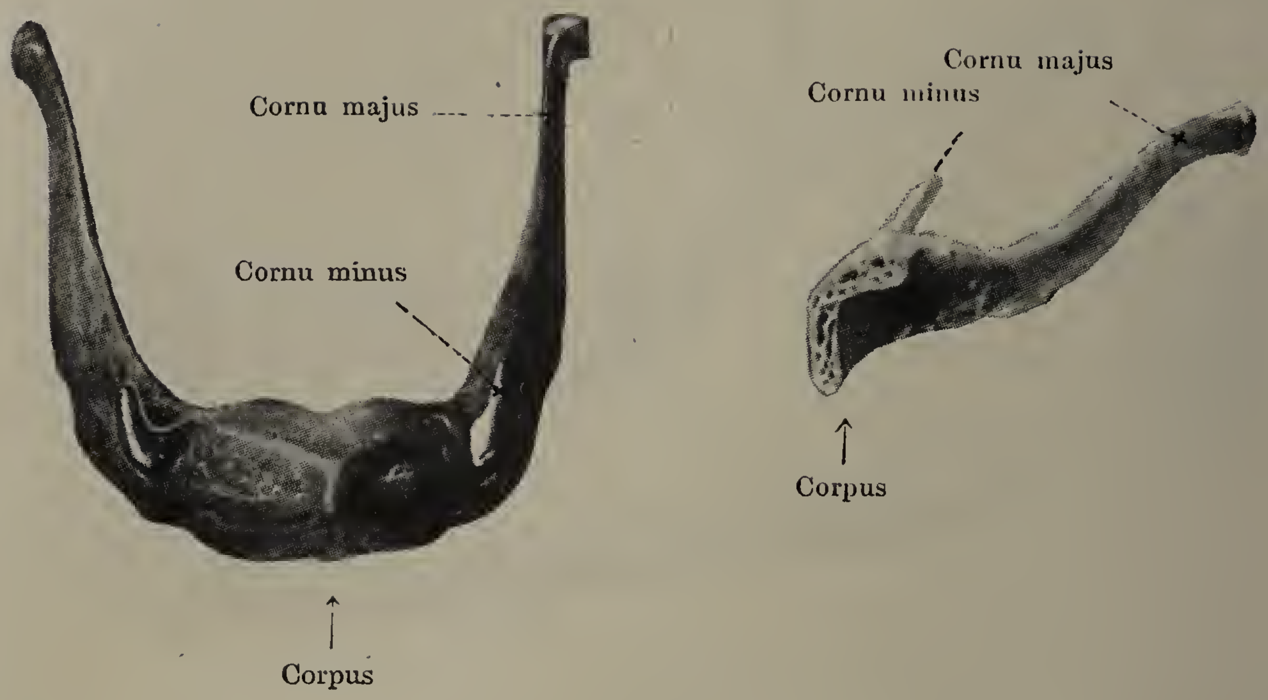
51. Adult.



52. Old age.

49—52. Lower jaw bones, ***mandibulae,***

at different ages of life, figures drawn to uniform scale.



53 and 54. Hyoid bone, *os hyoideum,*

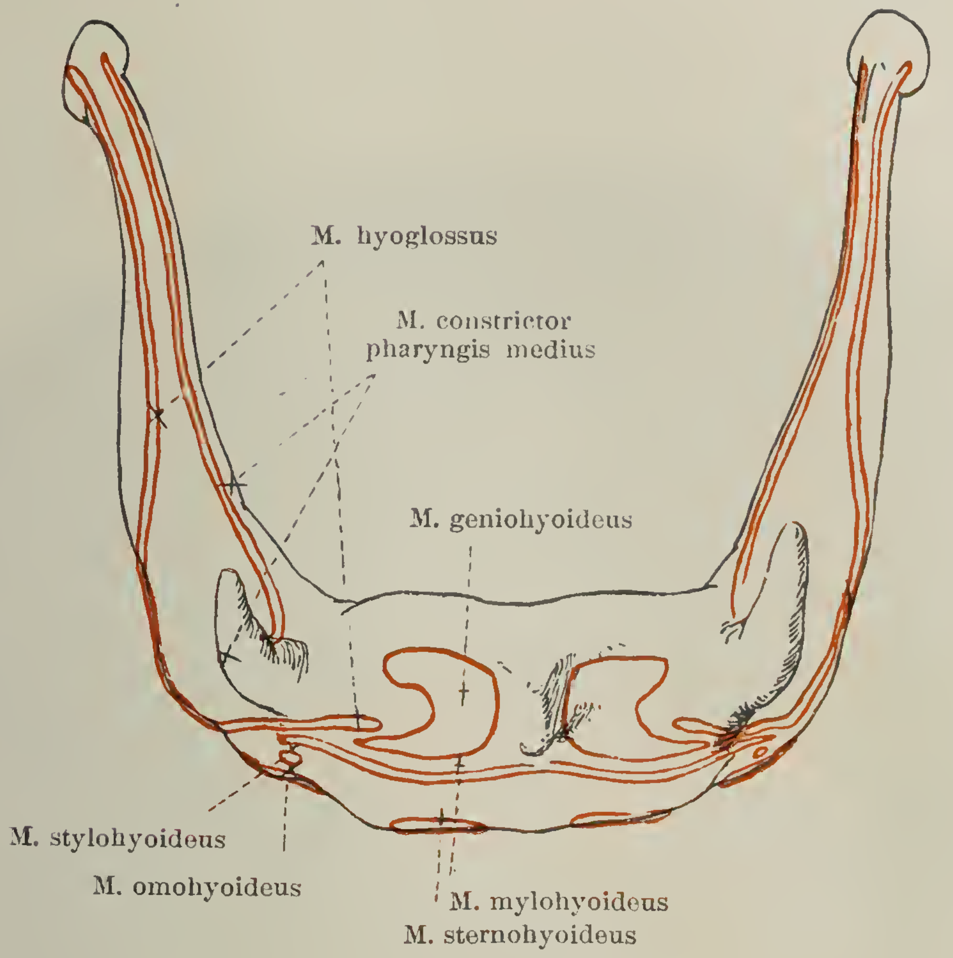
from above. right half, from the left.

The **os hyoideum** ***(hyoid bone)*** lies as an unpaired, horse-shoe-shaped bone behind and below the lower jaw between the muscles, without direct connection with the other bones. It is divisible into a middle piece or *corpus*, two *cornua majora* and two *cornua minora.* (For development see p. 71.)

The ***corpus (body)*** is a transversely placed oblong plate with an anterior surface, bent so as to be convex in front and above, and a concave posterior surface. The anterior surface presents variable developed ridges for the muscular attachments, the posterior is smooth. At the lateral ends are small fossae, below for union with the cornua majora, above for the cornua minora.

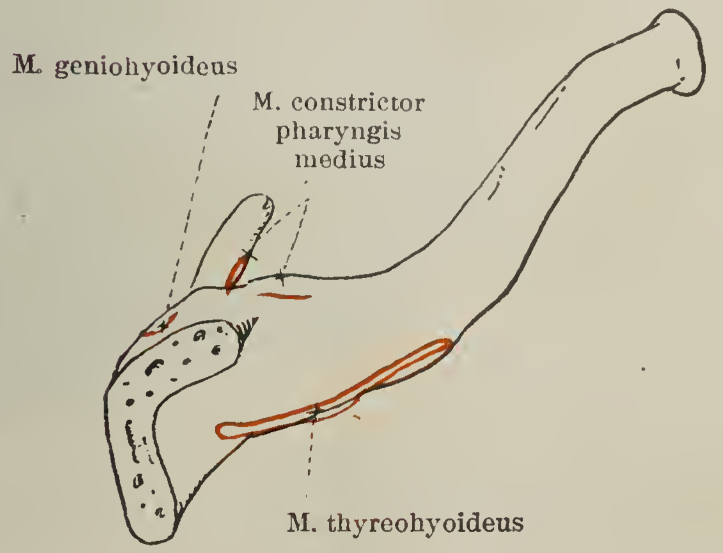
The ***cornua majora*** are thin, laterally flattened plates of bone, longer than the body. They are placed horizontally or directed obliquely upward, are united in front with the body by means of a narrow plate of cartilage or by a small joint with a joint cleft and a tight capsule. Behind, each ends in a small button-like projection. These merge in middle life with the corpus.

The ***cornua minora*** are small pieces, sometimes remaining cartilaginous, which are attached above near the point of union of the body and the cornua majora, either by means of a small joint with joint cleft and loose capsule or by ligamentous union only. They are surrounded by the end of the *ligamentum stylohyoideum* (see Fig. 605), a thin round elastic fibrous ligament which extends from the processus styloideus oss. tempor. interwoven in the deep layer of the cervical fascia. Sometimes it contains masses of bone, the single pieces being more or less separated from one another. The processus styloideus, the lig. stylohyoideum and the cornu minus oss. hyoid. arise from the second branchial arch of the embryo.



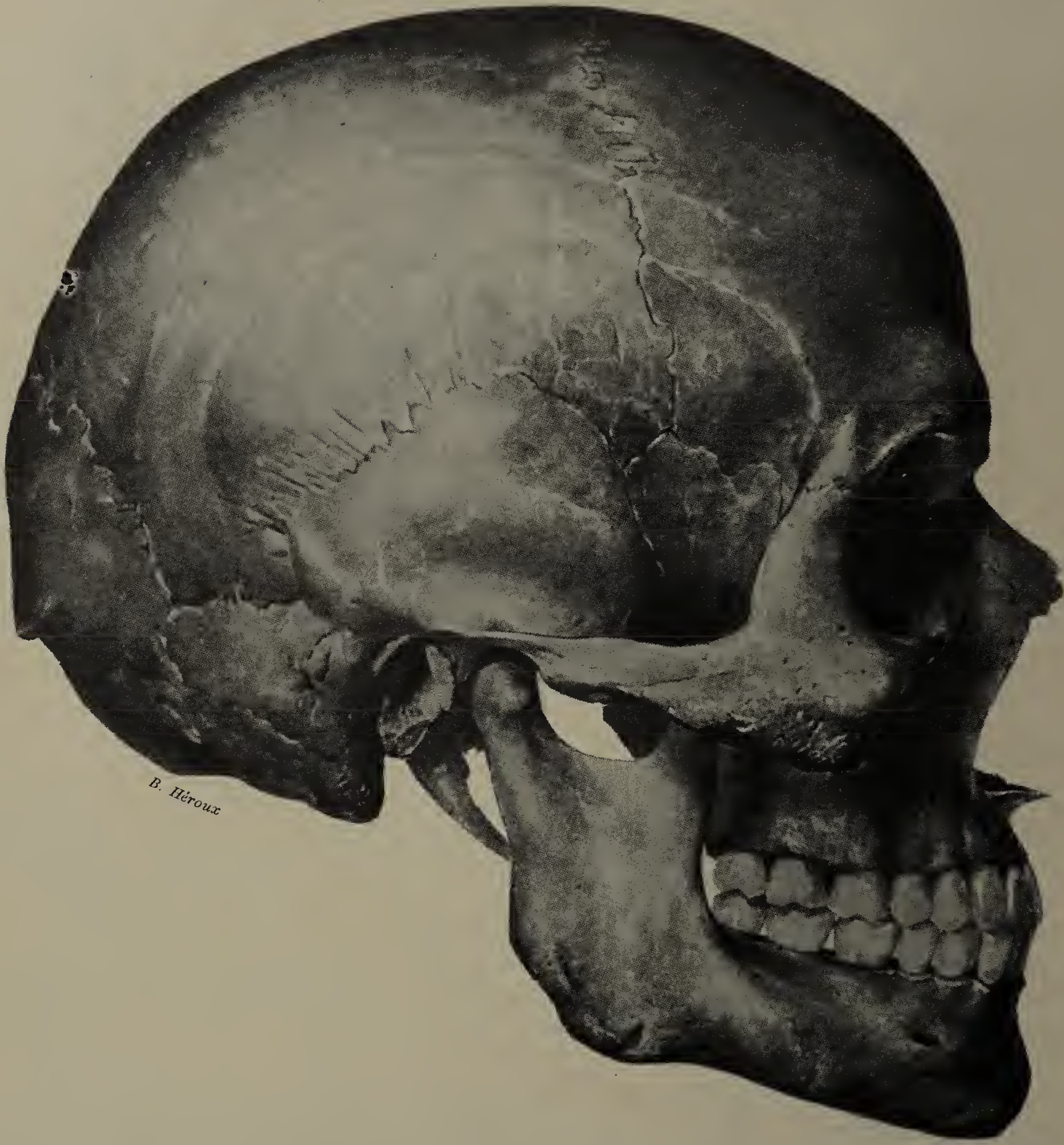
55. Hyoid bone, ***os hyoideum,*** from above, with muscular attachments.

Magnification: 3:2.

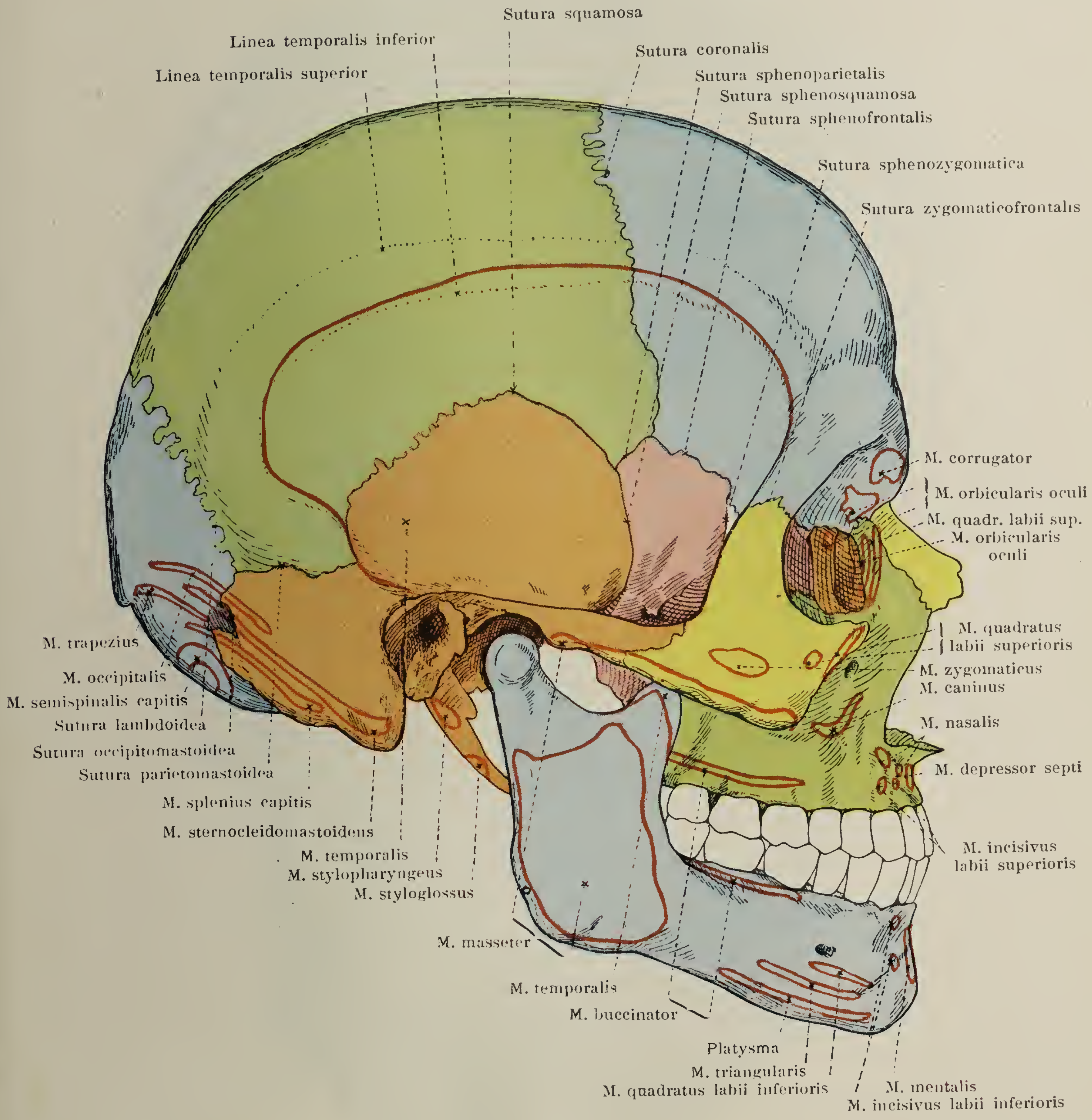


56. Hyoid bone, ***os hyoideum,*** right half, from the left, with muscular attachments.

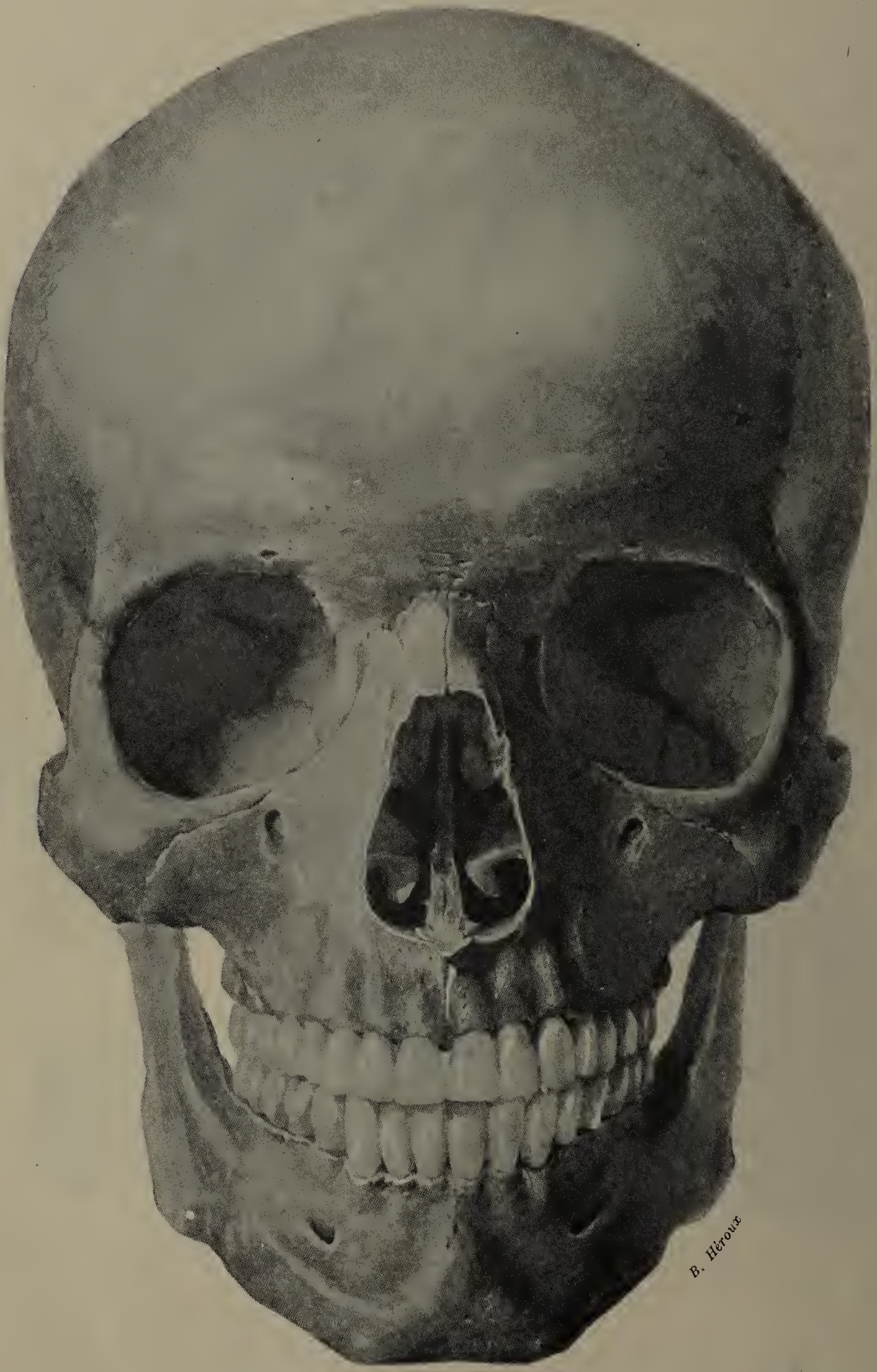
Magnification: 3:2.



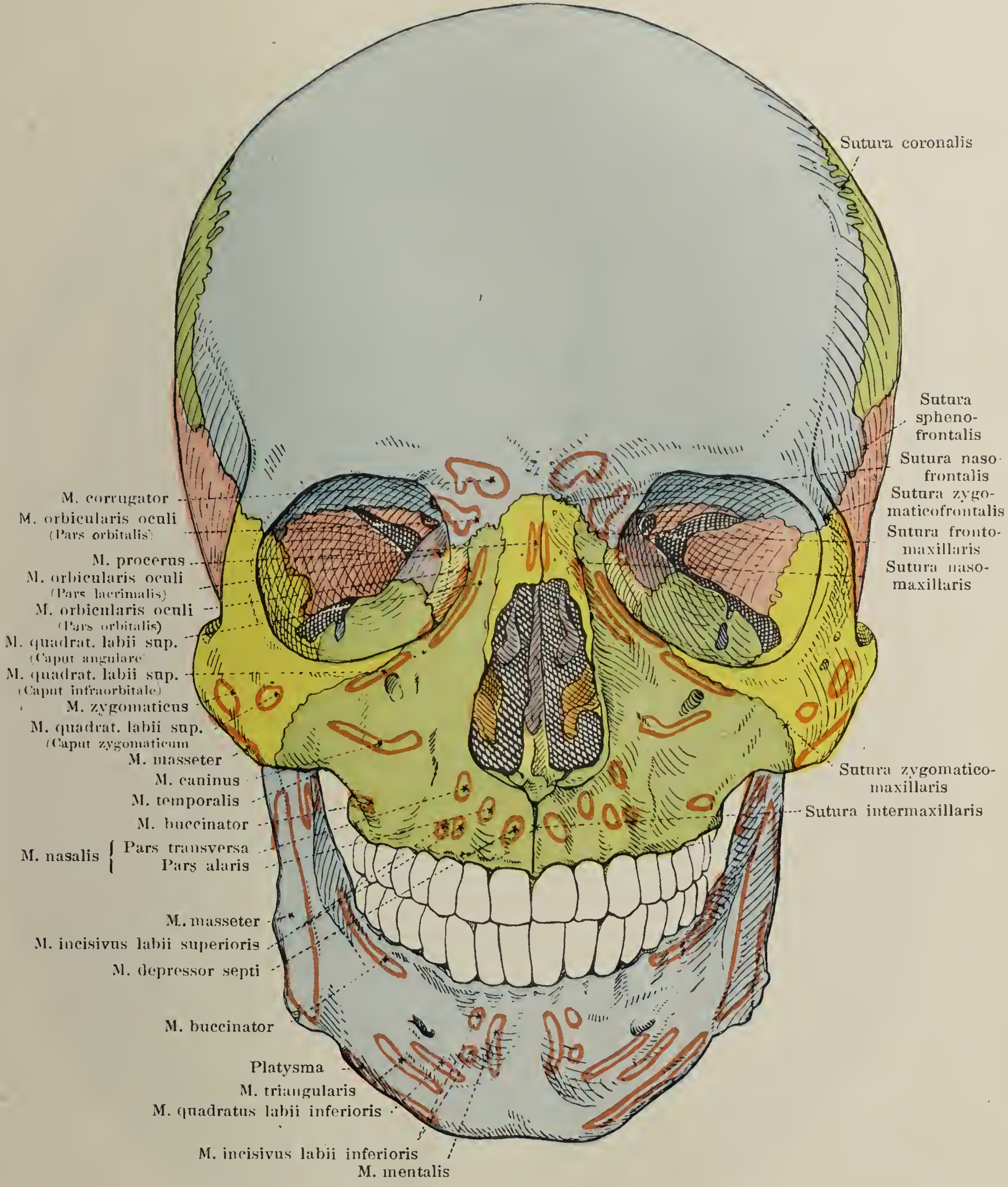
57. **Skull,** from the right.



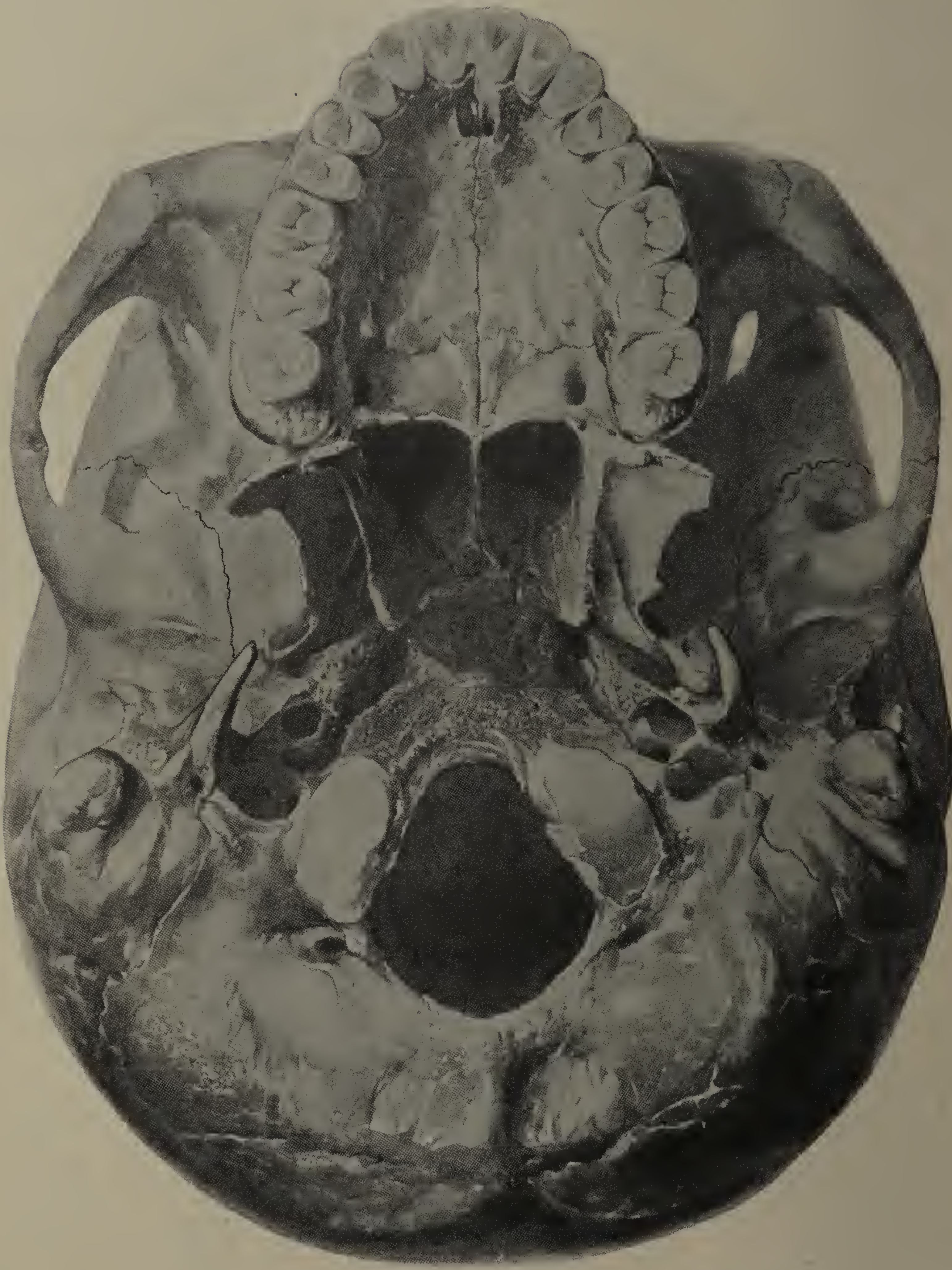
58. Skull, from the right, with muscular attachments.



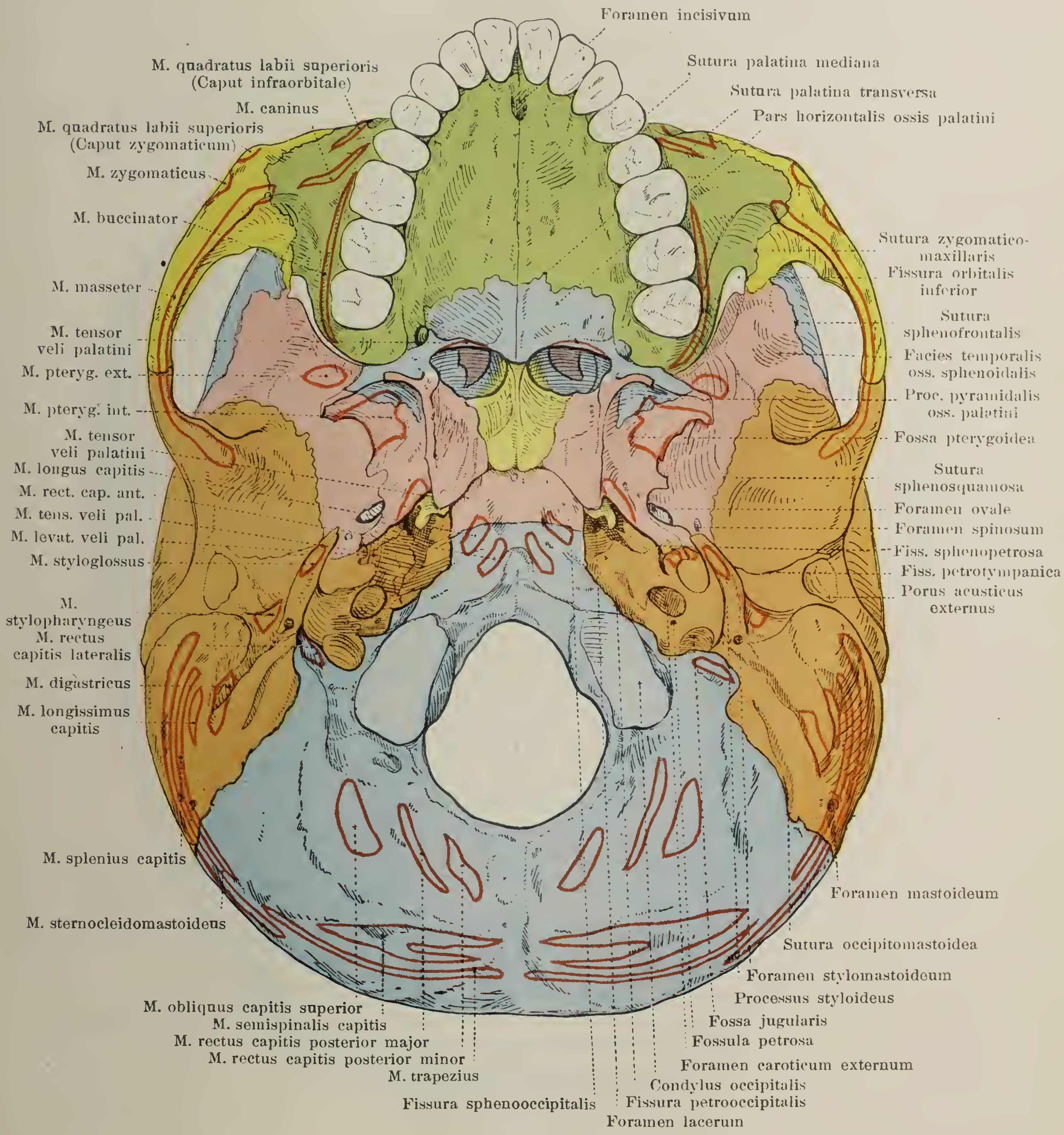
59. Skull, from in front.


Sutura coronalis
Sutura spheno-frontalis
Sutura naso-frontalis
Sutura zygomaticofrontalis
Sutura fronto-maxillaris
Sutura naso-maxillaris
M. corrugator
M. orbicularis oculi (Pars orbitalis)
M. procerus
M. orbicularis oculi (Pars lacrimalis)
M. orbicularis oculi (Pars orbitalis)
M. quadrat. labii sup. (Caput angulare)
M. quadrat. labii sup. (Caput infraorbitale)
M. zygomaticus
M. quadrat. labii sup. (Caput zygomaticum
M. masseter
M. caninus
M. temporalis
M. buccinator
M. nasalis { Pars transversa
Pars alaris
M. masseter
M. incisivus labii superioris
M. depressor septi
M. buccinator
Platysma
M. triangularis
M. quadratus labii inferioris
M. incisivus labii inferioris
M. mentalis
Sutura zygomatico-maxillaris
Sutura intermaxillaris

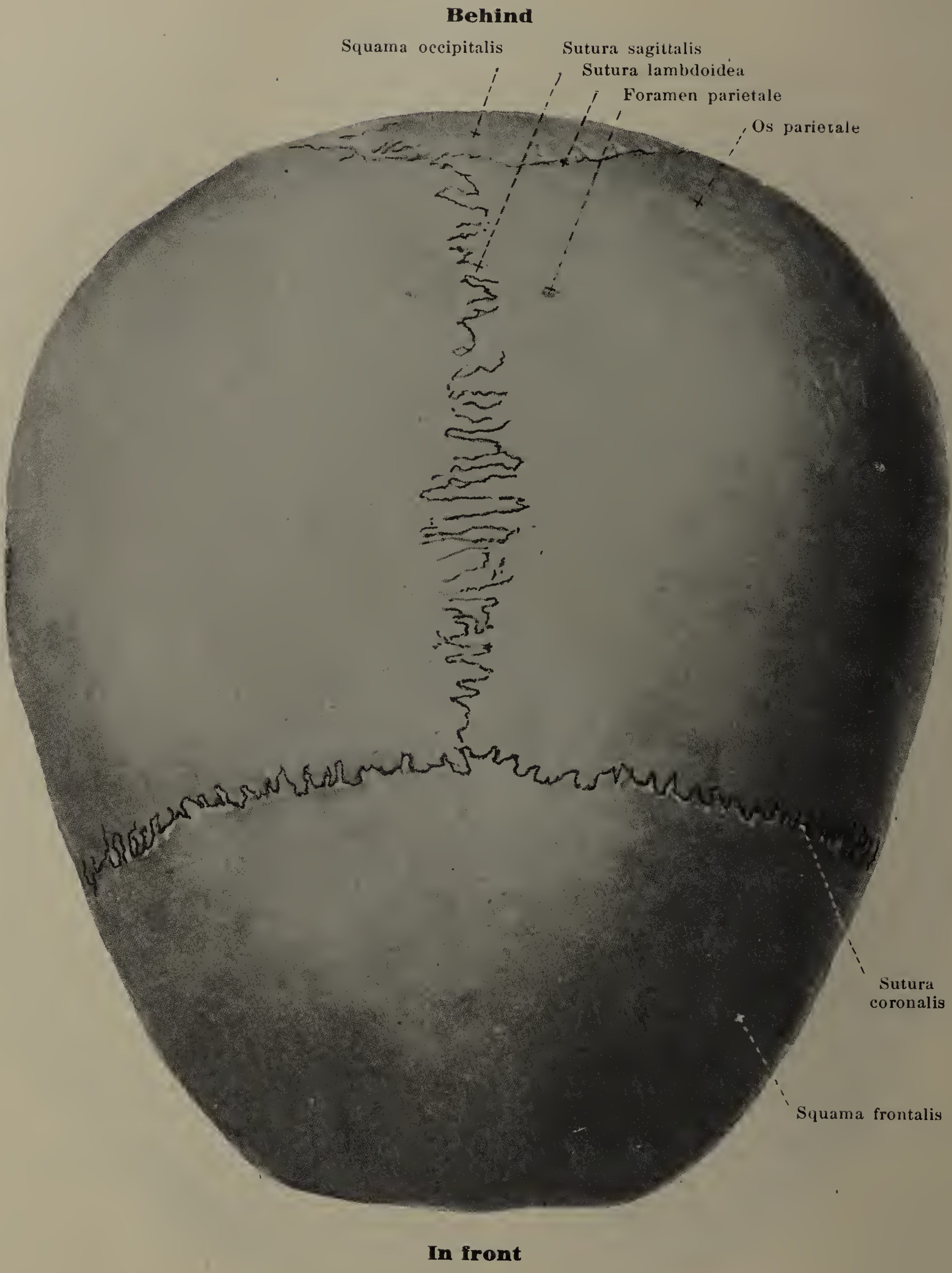
60. Skull, from in front, with muscular attachments.



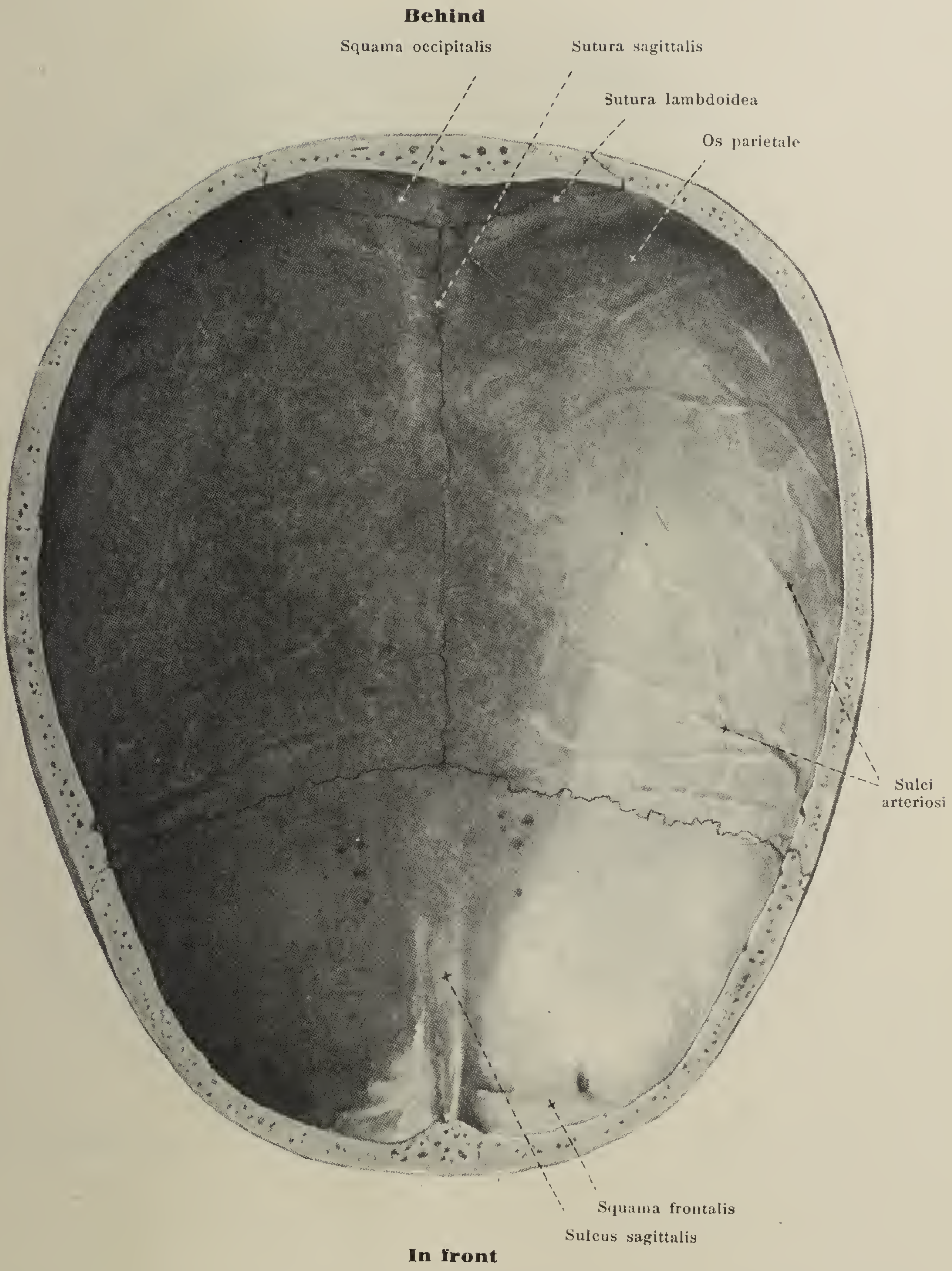
61. Base of the skull, from without, *basis cranii externa.*



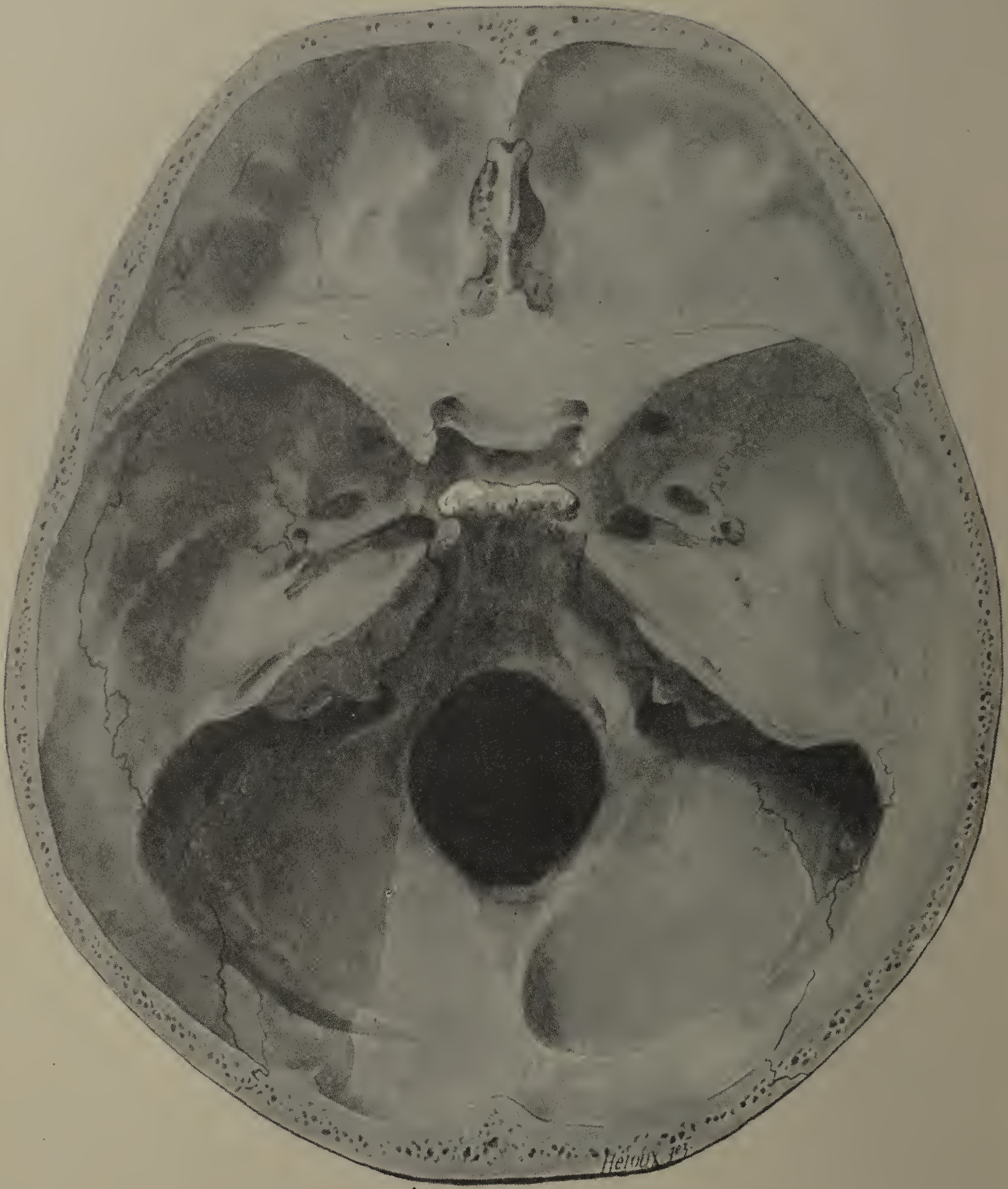
62. Base of the skull, from without, *basis cranii externa,* with muscular attachments.



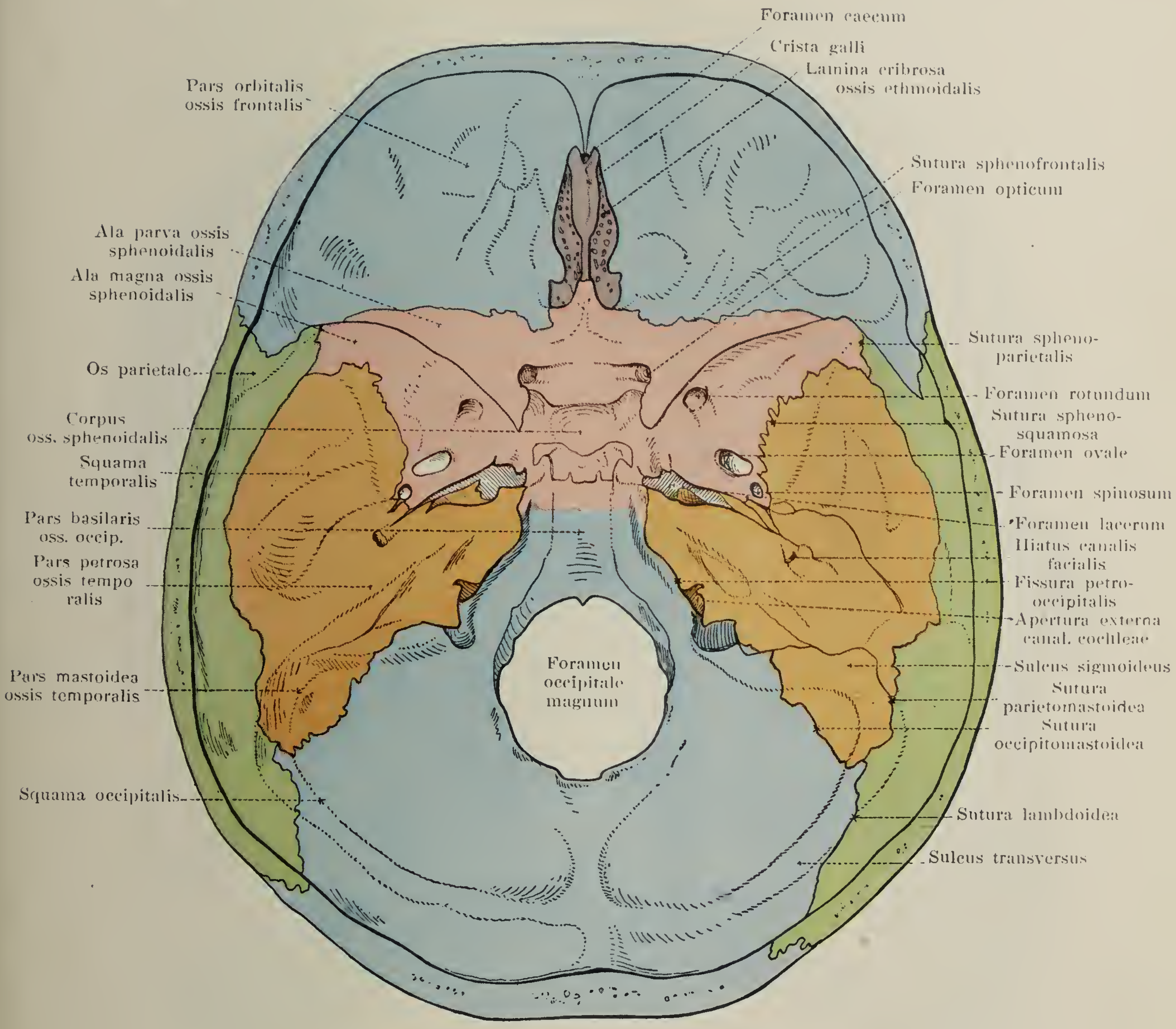
63. **Skull,** from above.



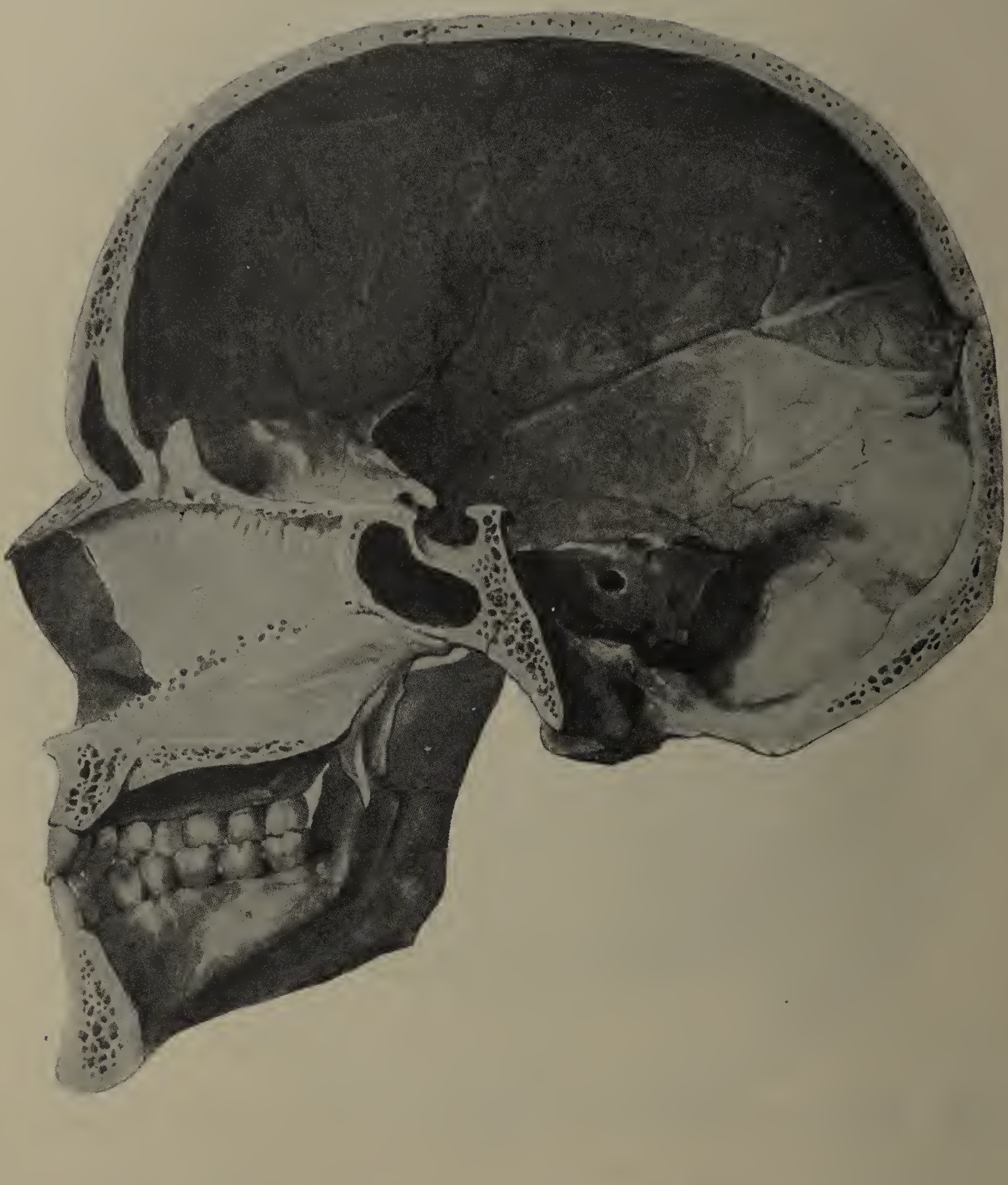
64. Skull cap, from within.



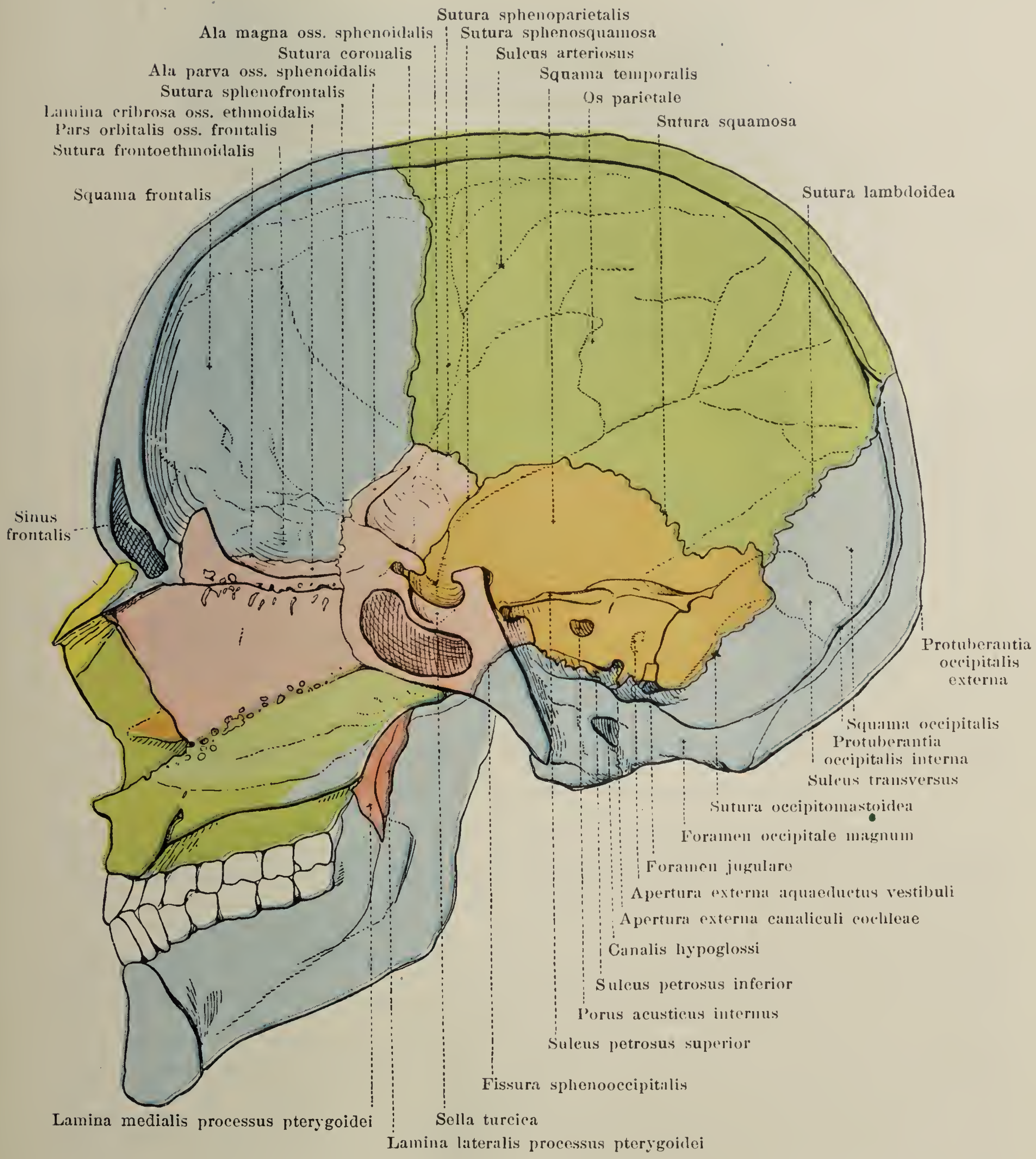
65. Base of the skull, from within, ***basis cranii interna.***



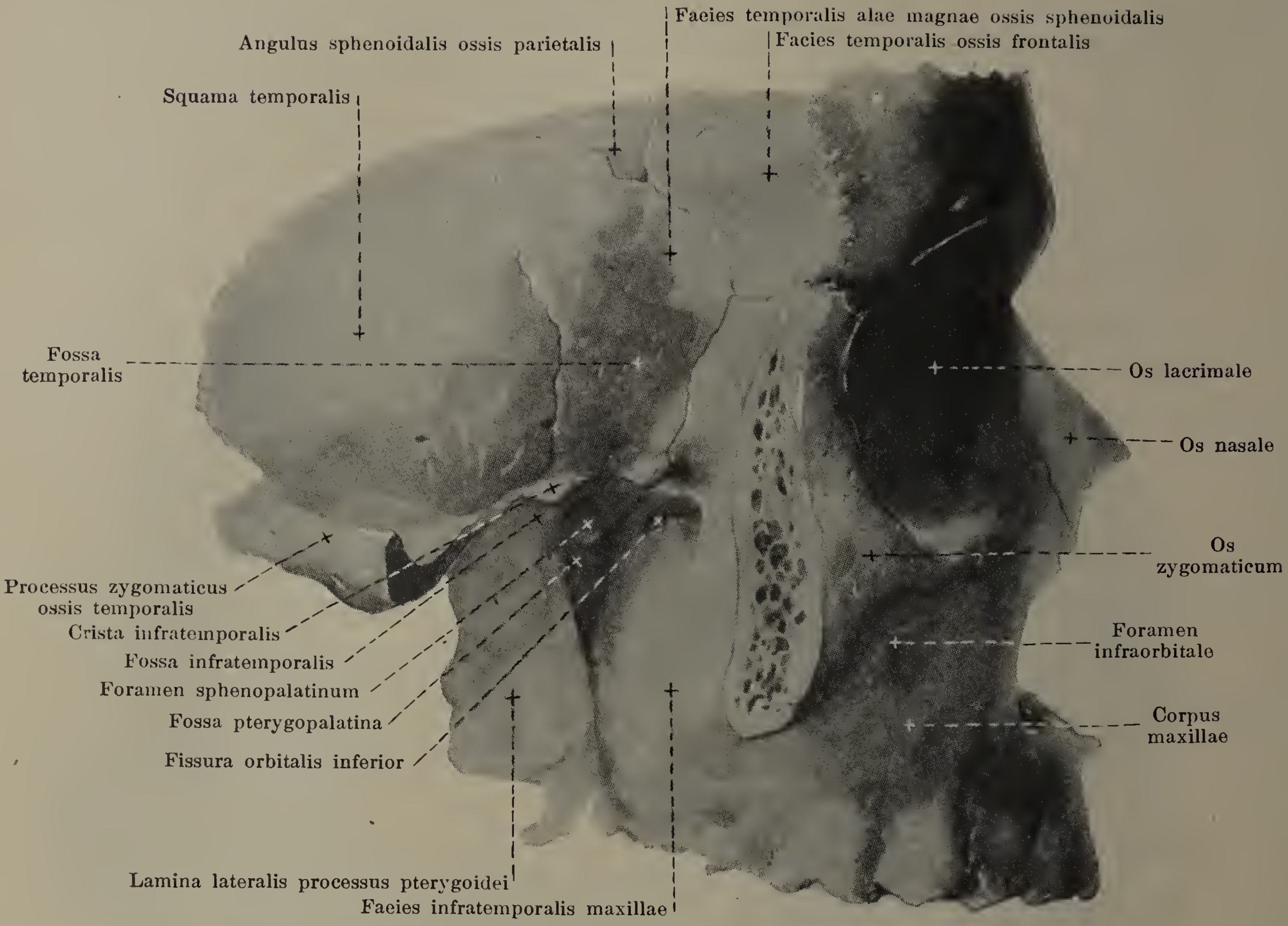
66. Base of the skull, from within, *basis cranii interna,* with names of various parts.



67. **Median section of the skull,** from the left.



68. Median section of the skull, from the left, with names of various parts.

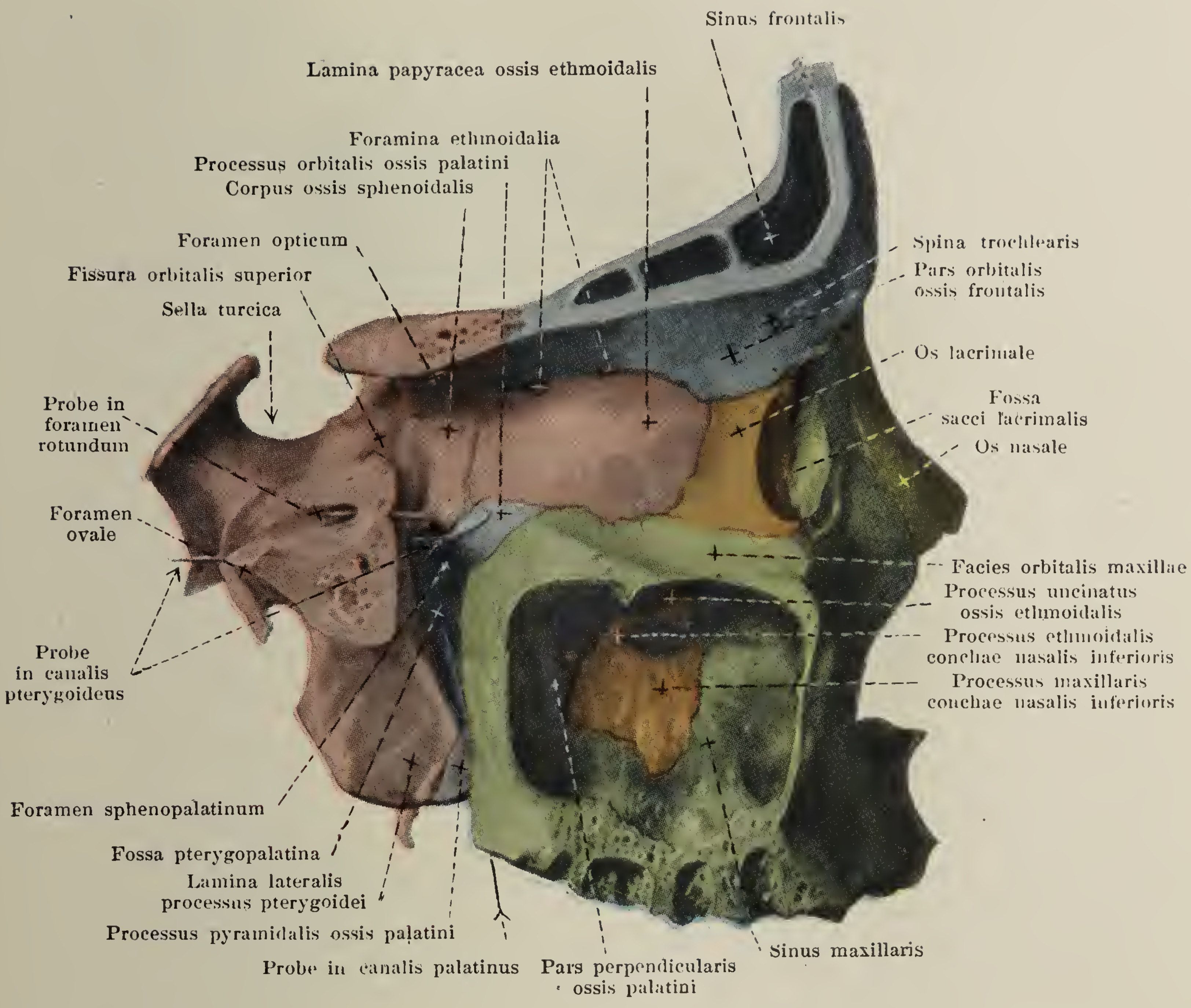

Facies temporalis alae magnae ossis sphenoidalis
Angulus sphenoidalis ossis parietalis
Facies temporalis ossis frontalis
Squama temporalis
Fossa temporalis
Os lacrimale
Os nasale
Os zygomaticum
Processus zygomaticus ossis temporalis
Crista infratemporalis
Fossa infratemporalis
Foramen infraorbitale
Foramen sphenopalatinum
Corpus maxillae
Fossa pterygopalatina
Fissura orbitalis inferior
Lamina lateralis processus pterygoidei
Facies infratemporalis maxillae

69. Right temporal fossa, *fossa temporalis,* from without.

(The arcus zygomaticus has been partially sawed away.)

The **fossa temporalis** (see also Figs. 57 and 58) lies on each side on the lateral surface of the skull and is, for the most part, open lateralward. Its medial surface is formed by the most inferior part of the facies parietal. oss. pariet., by the facies tempor. squamae tempor., the facies tempor. oss. front., and the facies tempor. of the ala magna oss. sphen.; the anterior surface by the facies tempor. oss. front. and the facies tempor. oss. zygom.; the external wall by the arcus zygom.. Below and medianward it goes over into the fossa infratempor.. On the medial surface run the *sutura squamosa* (between squama tempor. and margo squamos. oss. pariet.), the *sutura sphenosquamosa* (between squama tempor. and margo squamos. alae magnae oss. sphen.), the *sutura sphenoparietalis* (between angul. sphen. oss. pariet. and angul. pariet. alae magnae oss. sphen.), the *sutura coronalis* (between margo front. oss. pariet. and margo pariet. oss. front.), and the *sutura sphenofrontalis* (between pars orbital. oss. front. and margo front. alae magnae oss. sphen.); on the anterior surface, the *sutura zygomaticofrontalis* (between proc. zygom. oss. front. and proc. frontosphen. oss. zygom.), and the *sutura sphenozygomatica* (between os zygom. and margo zygom. alae magnae oss. sphen.); on the lateral surface the *sutura zygomaticotemporalis* (between proc. tempor. oss. zygom. and proc. zygom. oss. tempor.). On the anterior wall lies the foramen zygomaticotemporale.

The **fossa infratemporalis** (O. T. zygomatic fossa) (see also Figs. 61 and 62) lies on each side below and medianward from the arcus zygom., and goes over sideways above into the fossa tempor. and is open behind and below. Its upper wall is formed medianward by the facies infratemp. of the ala magna oss. sphen., the anterior oblique wall being formed by the facies infratempor. maxillae and the facies tempor. oss. zygom., the lateral wall by the ramus of the lower jaw and the medial by the lamina lat. proc. pteryg.. On the anterior surface the *sutura zygomaticomaxillaris* (between os zygom. and proc. zygom. maxillae) is visible. At the junction of the anterior and medial surfaces lies the entrance to the fossa pterygopalatina. On the anterior surface can be seen the foramina alveolaria on the tuber maxillare and above this the lateral extremity of the fissura orbitalis inferior.

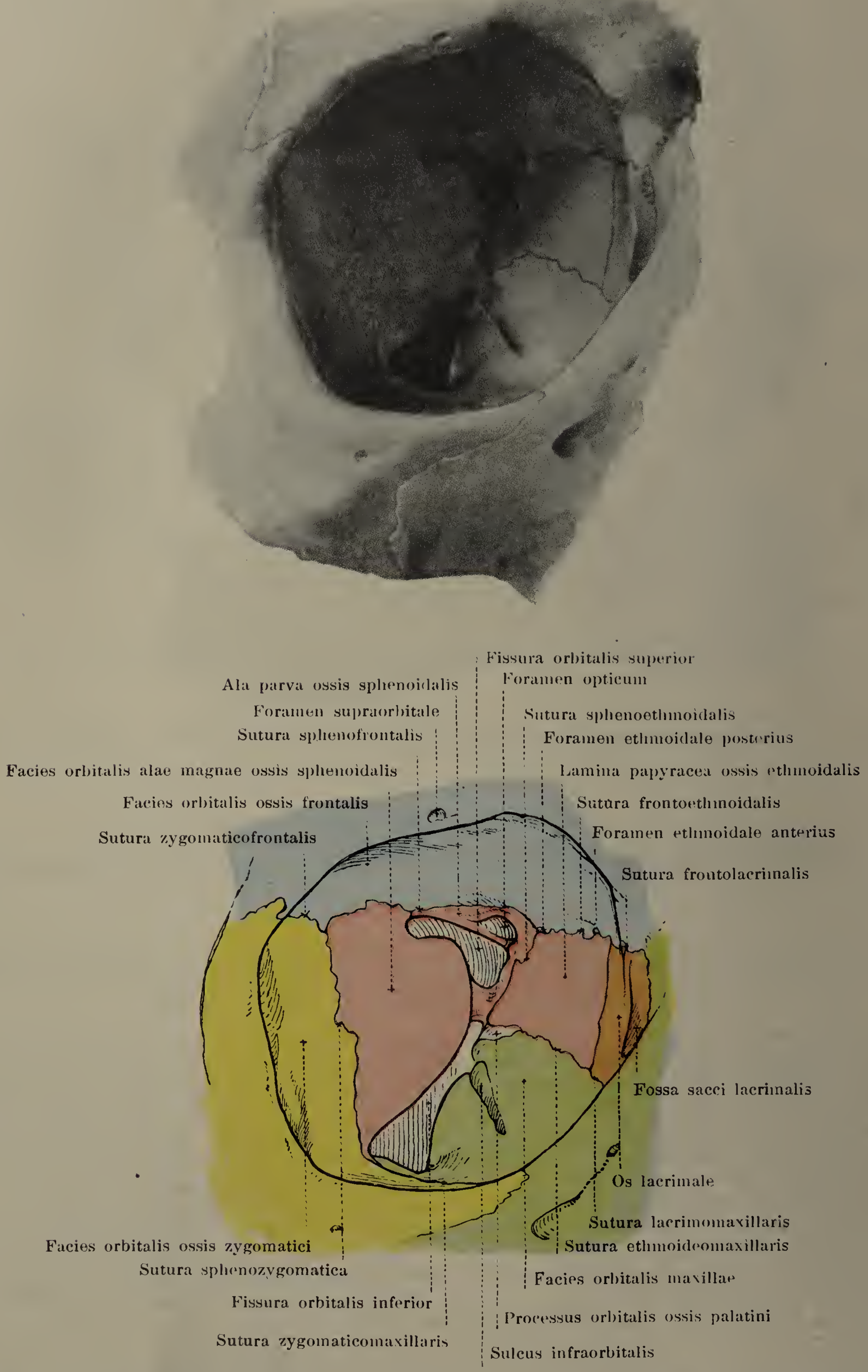

Sinus frontalis
Lamina papyracea ossis ethmoidalis
Foramina ethmoidalia
Processus orbitalis ossis palatini
Corpus ossis sphenoidalis
Foramen opticum
Fissura orbitalis superior
Sella turcica
Probe in foramen rotundum
Foramen ovale
Probe in canalis pterygoideus
Foramen sphenopalatinum
Fossa pterygopalatina
Lamina lateralis processus pterygoidei
Processus pyramidalis ossis palatini
Probe in canalis palatinus
Pars perpendicularis ossis palatini
Sinus maxillaris
Spina trochlearis
Pars orbitalis ossis frontalis
Os lacrimale
Fossa sacci lacrimalis
Os nasale
Facies orbitalis maxillae
Processus uncinatus ossis ethmoidalis
Processus ethmoidalis conchae nasalis inferioris
Processus maxillaris conchae nasalis inferioris

70. Right pterygopalatine fossa, *fossa pterygopalatina,*

from without.

(The main portion of the ala magna oss. sphenoid., of the lateral part of the corpus maxillae and of the pars orbit. oss. front. have been removed by a sagittal section, so that the medial wall of the sinus maxillaris and of the orbit is visible.)

The **fossa pterygopalatina** (O. T. sphenomaxillary fossa) (see also Fig. 69) lies, deeply concealed, between the bones medianward from the fossa infratemporalis. It is united with the latter by a sickel-shaped space, broad above, narrow below, which is closed below and lateralward by periosteum. Its medial wall is formed by the lateral surface of the pars perpendicularis oss. palatini, its upper wall by the anterior lateral portion of the inferior surface of the body of the sphenoid., the posterior by the sphenomaxillary surface of the ala magna oss. sphenoidalis and by the anterior surface of the processus pterygoideus, the anterior by the processus orbitalis oss. palatini and by the most posterior margin of the corpus maxillae. Below it narrows to become the *canalis pterygopalatinus* which is continued into the canales palatini oss. palatini and opens at the foramina palatina majus et minora on the under surface of the hard palate; in addition, delicate canals pass through the pars perpendicularis oss. palatini from the canalis pterygopalatinus into the nose. On the anterior wall connection is made with the orbit by means of the fissura orbitalis inferior, with the anterior surface of the face by the sulcus and canalis infraorbitalis. On the medial surface, the wide foramen sphenopalatinum leads into the nose. From the posterior surface the foramen rotundum goes into the cavity of the skull, the canalis pterygoideus and the canalis pharyngeus to the lower surface of the base of the skull.


Fissura orbitalis superior
Foramen opticum
Ala parva ossis sphenoidalis
Foramen supraorbitale
Sutura sphenofrontalis
Sutura sphenoethmoidalis
Foramen ethmoidale posterius
Facies orbitalis alae magnae ossis sphenoidalis
Lamina papyracea ossis ethmoidalis
Facies orbitalis ossis frontalis
Sutura frontoethmoidalis
Sutura zygomaticofrontalis
Foramen ethmoidale anterius
Sutura frontolacrimalis
Fossa sacci lacrimalis
Os lacrimale
Sutura lacrimomaxillaris
Facies orbitalis ossis zygomatici
Sutura ethmoideomaxillaris
Sutura sphenozygomatica
Facies orbitalis maxillae
Fissura orbitalis inferior
Processus orbitalis ossis palatini
Sutura zygomaticomaxillaris
Sulcus infraorbitalis

71 and 72. Right orbital cavity, *orbita,* from in front.
Magnification: 5:4.

The **orbita** *(orbital cavity)* (see also Figs. 57—60, 70—75) lies on each side in the upper part of the skull and, above, adjoins the cerebral skull. It opens in front by a wide mouth, *aditus orbitae*, behind this widens suddenly in its lateral half and then narrows gradually from before backward. Its shape, in front, is that of a four-sided, behind, that of a three-sided pyramid, since the medial and the inferior wall form in front an obtuse angle with one another, while further back, they lie almost in one plane. The axes of the two orbital cavities (from the middle of the anterior opening to the middle of the foramen opticum) converge behind to the region above the sella turcica and are in addition inclined, in front, somewhat downward.

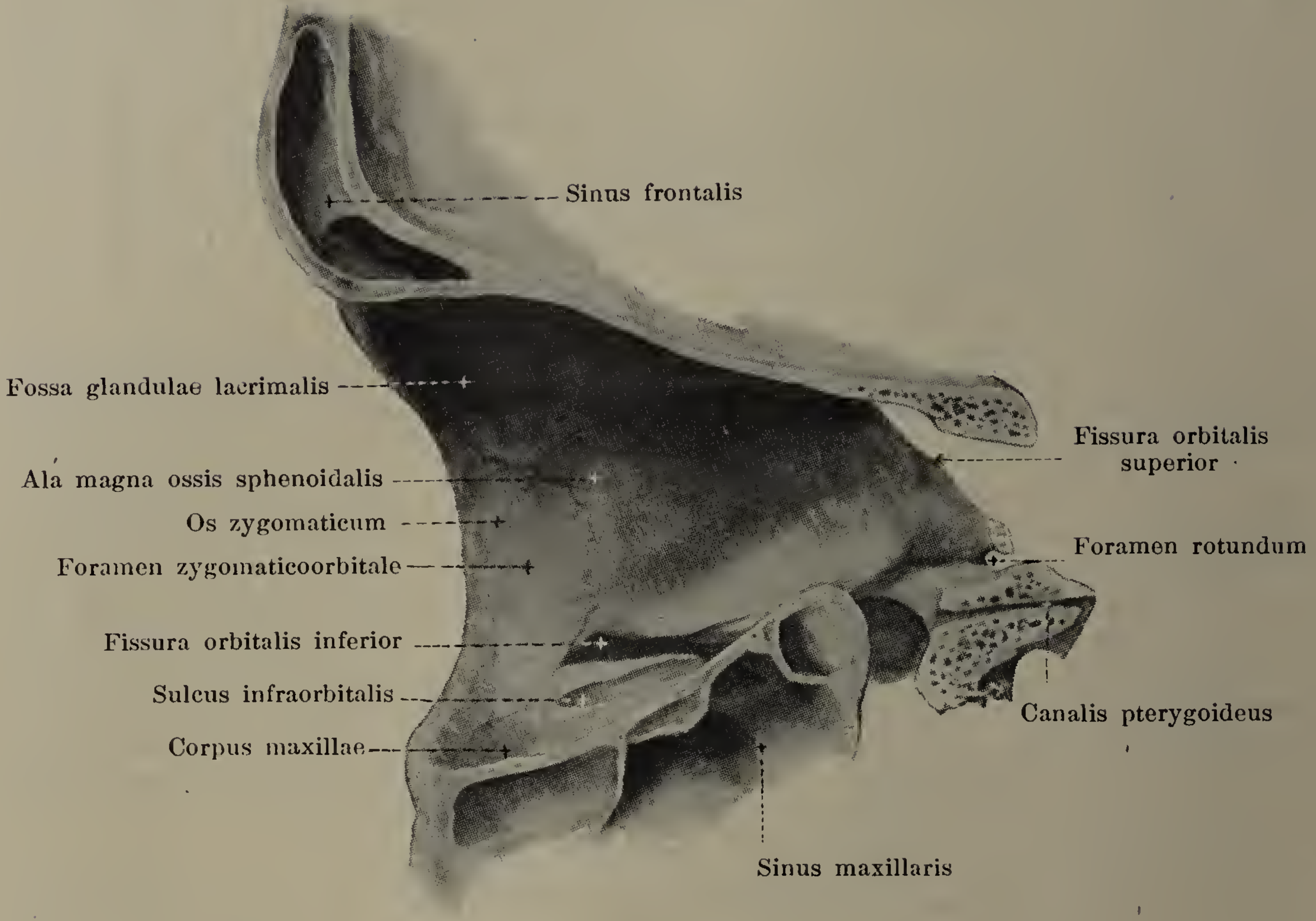
The walls of the orbit go over into one another, usually with rounded angles, and are lined by a thin periosteum, the *periorbita.*

The opening of entrance, ***aditus orbitae*** is quadrangular. Te upper margin, *margo supraorbitalis*, is formed by the margo supraorbitalis and proc. zygomat. oss. frontalis, the medial by the pars nasalis oss. frontalis and the proc. frontalis maxillae, the inferior, *margo infraorbitalis*, by the corpus maxillae and os zygomaticum, the lateral by the os zygomaticum.

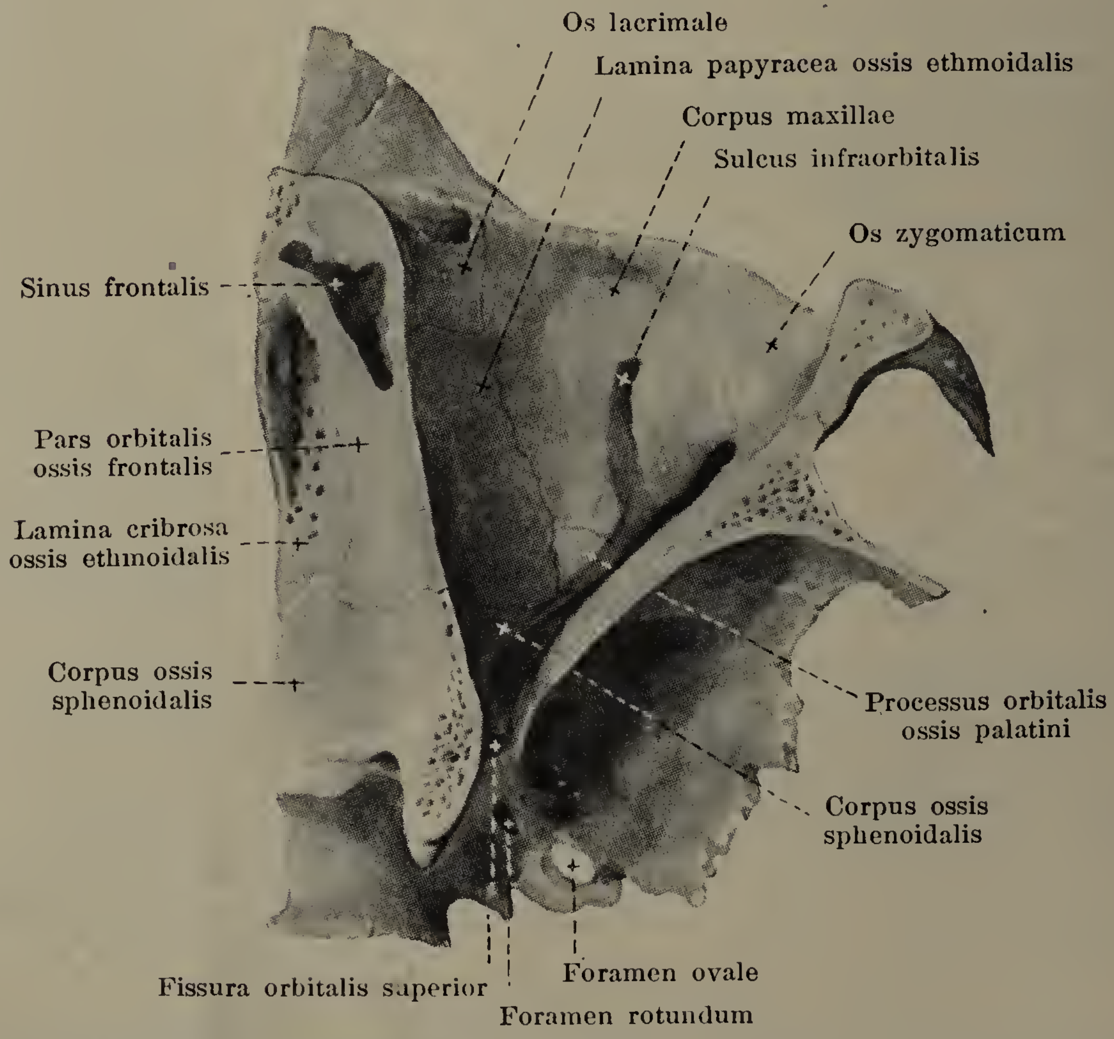
The medial wall, ***paries medialis*** (see also Fig. 70), is placed nearly sagittally. It is composed of the os lacrimale, the lamina papyracea oss. ethmoidalis and the lateral surface of the corpus oss. sphenoidalis. It presents the *sutura lacrimomaxillaris* (between os lacrimale and proc. frontalis maxillae), the *sutura frontolacrimalis* (between os lacrimale and pars orbitalis oss. frontalis), the *sutura frontoethmoidalis* (between pars orbitalis oss. frontalis and os ethmoidale) as well as the *sutura sphenoethmoidalis* (between os ethmoidale and corpus oss. sphenoidalis). Near the anterior margin lies the fossa sacci lacrimalis. At the junction of the medial with the upper wall go off the foramina ethmoidalia anterius et posterius, of which the anterior leads constantly into the skull cavity upon the lamina cribrosa oss. ethmoidalis, the posterior also to the same place or only as far as the posterior ethmoidal cells. From the most posterior angle the foramen opticum passes to the skull cavity.

The lateral wall, ***paries lateralis*** (see also Figs. 71 and 72) is vertical and inclined from in front and lateralward obliquely behind and medianward. It is composed of the facies orbitalis oss. zygomatici, the facies orbitalis of the ala magna oss. sphenoidalis, partly also of the medial surface of the processus zygomaticus oss. frontalis. Between these bones run the *sutura sphenozygomatica* (between os zygomaticum and ala magna oss. sphenoidalis), the *sutura zygomaticofrontalis* (between processus frontosphenoidalis oss. zygomatici and processus zygomaticus oss. frontalis), as well as the *sutura sphenofrontalis* (between ala magna oss. sphenoidalis and pars orbitalis oss. frontalis). Here can be seen also the single or double foramen zygomaticoorbitale which leads to the facial surface and to the fossa temporalis, and the *fissura orbitalis superior* (O. T. sphenoidal fissure or foramen lacerum anterius). The latter is found on the boundary between the lateral and the superior wall and occupies the whole medial half of the same; it is narrow and acute-angled lateralward and broadens medianward, usually suddenly, to terminate there, rounded off, below the foramen opticum; it leads into the skull cavity, but is, in its larger part, closed by tough connective tissue and periosteum.

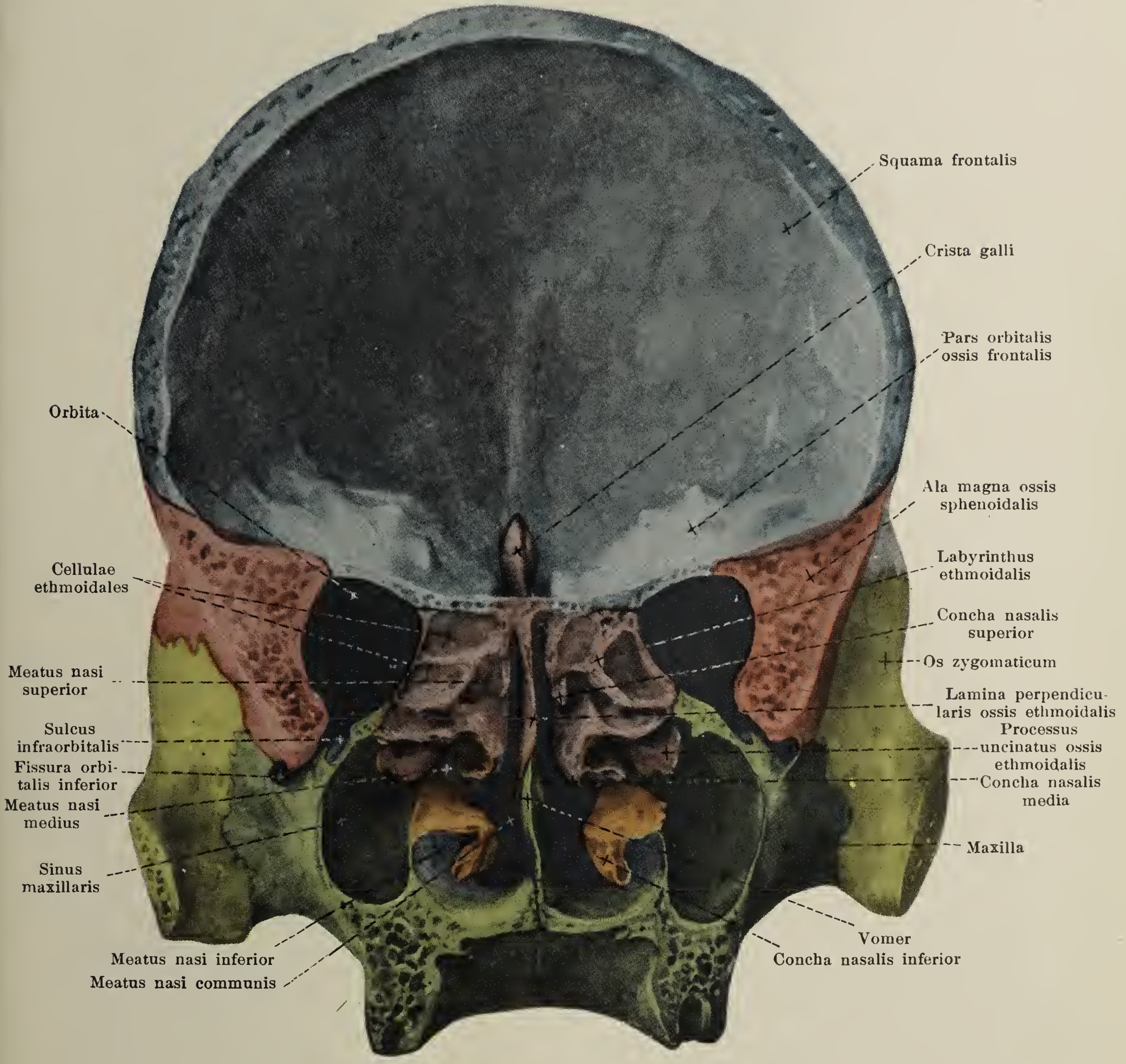
The inferior wall of the orbit, ***paries inferior*** (see also Figs. 71 and 72), is inclined somewhat obliquely downward, forward and lateralward. It is formed chiefly by the facies orbitalis corporis maxillae, besides, lateralward, by a part of the facies orbitalis oss. zygomatici, and behind by the processus orbitalis oss. palatini. At the boundary between the inferior and the medial wall one sees the *sutura lacrimomaxillaris* (between os lacrimale and corpus maxillae), the *sutura ethmoideomaxillaris* (between os ethmoidale and corpus maxillae), the *sutura palatoethmoidalis* (between os ethmoidale and proc. orbitalis oss. palatini), the *sutura sphenoorbitalis* (between corpus oss. sphenoidalis and processus orbitalis oss. palatini), besides, near the posterior angle, the *sutura palatomaxillaris* (between corpus maxillae and processus orbitalis oss. palatini) and near the lateral margin the *sutura zygomaticomaxillaris* (between processus zygomaticus maxillae and os zygomaticum). It is united by bone with the lateral wall only in the anterior half, but is separated from it in the posterior half by the *fissura orbitalis inferior* (O. T. sphenomaxillary fissure). This slit, running between the posterior margin of the facies orbitalis corporis maxillae and the inferior margin of the facies orbitalis alae magnae oss. sphenoidalis, is, lateralward, closed either by a small process of one of these two bones (see Figs. 71 and 72) or by the os zygomaticum (see Fig. 73). The slit is often broader lateralward than medianward, leads externally into the fossa infratemporalis, internally into the fossa pterygopalatina and is for the most part closed by tough connective tissue and periosteum. From its medial extremity a groove passes to the fissura orbitalis superior. At about its middle begins the sulcus infraorbitalis; it is shut off from the orbit by the periorbita and after a course of variable length is covered with bony substance thus becoming the canalis infraorbitalis which opens on the facial surface at the foramen infraorbitale.


Sinus frontalis
Fossa glandulae lacrimalis
Ala magna ossis sphenoidalis
Os zygomaticum
Foramen zygomaticoorbitale
Fissura orbitalis inferior
Sulcus infraorbitalis
Corpus maxillae
Fissura orbitalis superior
Foramen rotundum
Canalis pterygoideus
Sinus maxillaris

73. Right orbital cavity, ***orbita,*** lateral wall, from the left.
(The medial part of the orbit has been removed by an approximately sagittal section.)

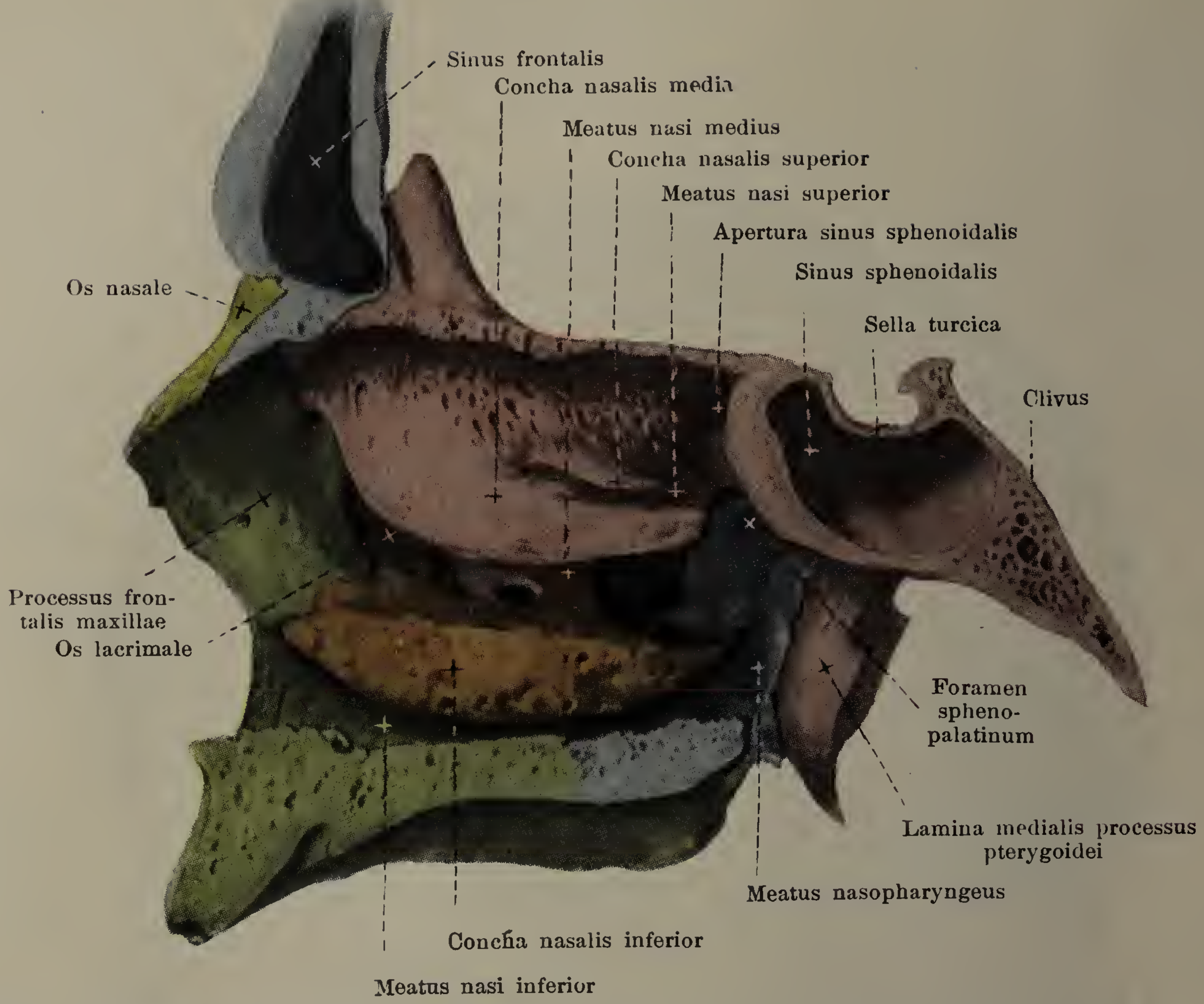

Os lacrimale
Lamina papyracea ossis ethmoidalis
Corpus maxillae
Sulcus infraorbitalis
Os zygomaticum
Sinus frontalis
Pars orbitalis ossis frontalis
Lamina cribrosa ossis ethmoidalis
Corpus ossis sphenoidalis
Processus orbitalis ossis palatini
Corpus ossis sphenoidalis
Fissura orbitalis superior
Foramen ovale
Foramen rotundum

74. Right orbital cavity, ***orbita,*** inferior wall, from above.



75. Frontal section of the skull, from behind.

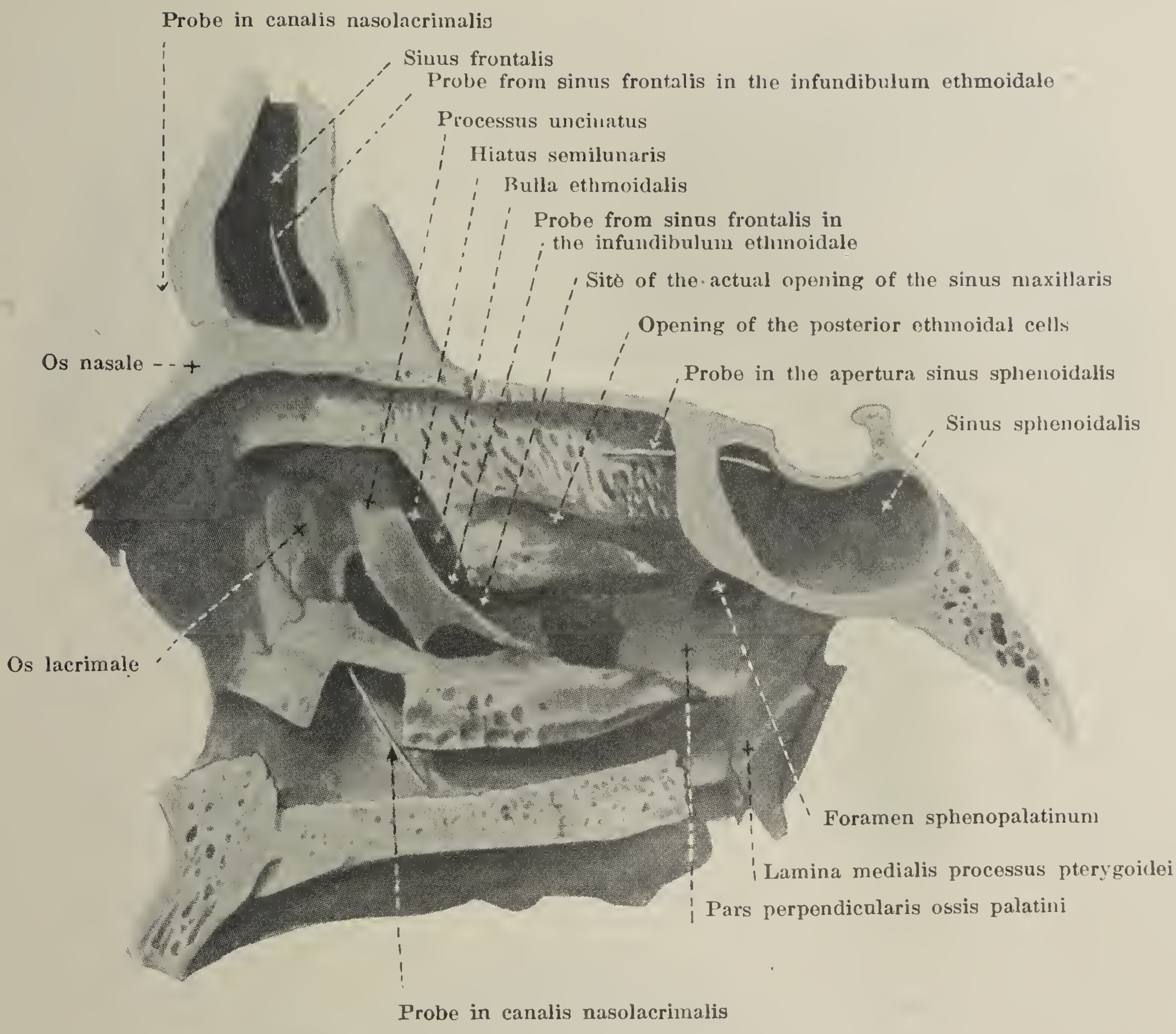
Orbital cavity (continued). The upper wall, ***paries superior*** (see also Figs. 71—73) is horizontal, and formed by the pars orbitalis oss. frontalis and the ala parva oss. sphenoidalis; it is smooth, and slightly hollowed out. Part of the *sutura sphenofrontalis* is visible between these two bones. It contains also anteriorly and lateralward the fossa glandulae lacrimalis, medially the fovea trochlearis, and occasionally laterally from the latter the spina trochlearis.



76. Nasal cavity, ***cavum nasi,*** right lateral wall, from the left.

The **cavum nasi** *(nasal cavity)* (see also Figs. 59—62, 75, 77 and 78) is unpaired and lies in the middle and upper part of the facial skull. It consists of the nasal cavity proper and the accessory cavities which surround the former in front and above, lateralward and behind; these accessory cavities, ***sinus paranasales***, are the ***sinus frontales*** (in front and above), the ***cellulae ethmoidales*** (lateralward almost in the whole depth), the ***sinus sphenoidales*** (behind and above) and the ***sinus maxillaris*** (lateralward).

The ***lateral wall*** (see also Figs. 61, 62, 75 and 77) is nearly sagittal, but somewhat inclined from above and medianward downward and lateralward. It is formed in front by the medial surface of the proc. frontalis maxillae, in front and in the middle by the facies nasalis corpor. maxillae, further by the os lacrimale, by the medial wall of the labyrinthus ethmoidalis, by the concha nasalis inferior, by the facies nasalis of the pars perpendicularis oss. palatini and by the medial surface of the lamina medialis of the proc. pterygoideus oss. sphenoidalis. From these bones hang down free usually four, sometimes three, conchae nasales (turbinated bones) which cover over partially medianward three oblong fossae, the ***nasal passages.*** The ***meatus nasi superior (upper nasal passage),*** between the concha nasalis superior and media of the os ethmoid., is the shortest and narrowest, present only in the posterior half of the nasal cavity; it descends somewhat obliquely toward the upper circumference of the foramen sphenopalatinum. The ***meatus nasi medius (middle nasal passage),*** between the concha media and the concha inferior, reaches from the anterior margin of the middle concha as far as the region of the foramen sphenopalatinum. The ***meatus nasi inferior (inferior nasal passage),*** between the concha nasal. inferior and the inferior wall of the nasal cavity, is the longest and at the same time the most capacious. Above the concha nasalis superior, between the latter and the concha nasalis suprema, usually runs like a fourth nasal passage, the ***recessus sphenoethmoidalis*** in the form of a groove of variable depth obliquely backward and downward into the region of the foramen sphenopalatinum. Lateralward from the septum, medianward from the conchae there remains a slit-shaped space between which extends through the whole height of the nasal space, the ***meatus nasi communis.*** The part of the cavity situated on each side behind the posterior ends of the conchae is called the ***meatus nasopharyngeus;*** it is bounded above by the inferior surface of the body of the sphenoid., the ala vomeris, the proc. vaginalis of the proc. pteryg. oss. sphenoid. and the proc. sphenoidalis oss. palat., lateralward by the pars perpendicularis oss. palat. and the lamina medialis proc. pteryg., below by the pars horizontalis oss. palat. and medianward by the vomer; behind, it opens by means of the ***choana*** (O. T. posterior nares) (bounded by the same bones).


Probe in canalis nasolacrimalis
Sinus frontalis
Probe from sinus frontalis in the infundibulum ethmoidale
Processus uncinatus
Hiatus semilunaris
Bulla ethmoidalis
Probe from sinus frontalis in the infundibulum ethmoidale
Site of the actual opening of the sinus maxillaris
Opening of the posterior ethmoidal cells
Probe in the apertura sinus sphenoidalis
Sinus sphenoidalis
Os nasale
Os lacrimale
Foramen sphenopalatinum
Lamina medialis processus pterygoidei
Pars perpendicularis ossis palatini
Probe in canalis nasolacrimalis

77. Nasal cavity, *cavum nasi*, right lateral wall, from the left.

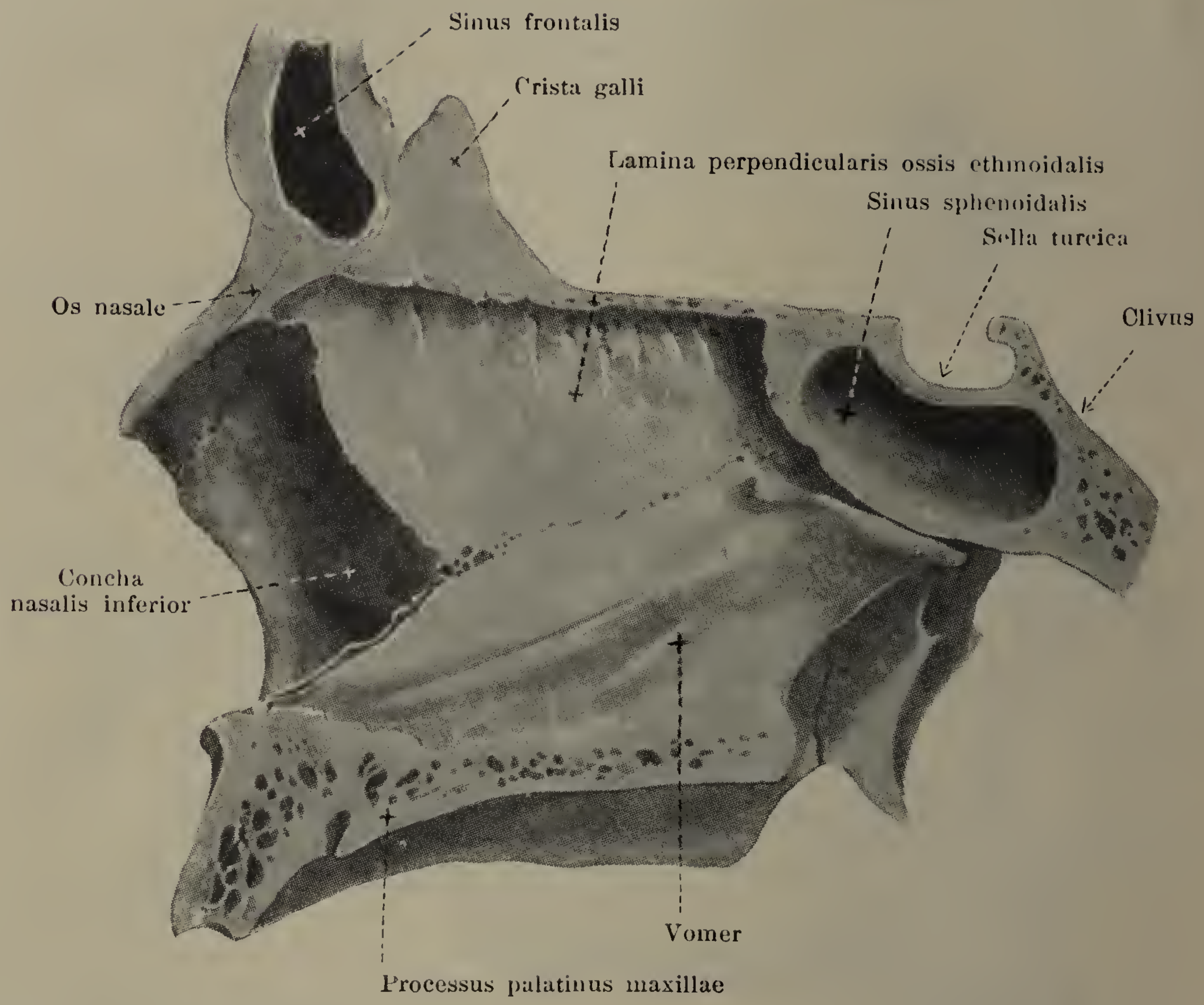
(The middle and inferior turbinated bones have been partially removed.)

In the ***meatus nasi inferior***, near the anterior end, lies the lower opening of the ***canalis nasolacrimalis***. This goes out from the fossa sacci lacrimalis and is formed lateralward and in front by the sulcus lacrimalis of the corpus and of the proc. frontalis maxillae, medianward and behind by the sulcus lacrimalis oss. lacrimalis and the proc. lacrimalis conchae nasalis inferioris; it is directed from above downward and at the same time somewhat from before backward.

Into the ***meatus nasi medius*** opens the sinus maxillaris. The opening does not correspond to the whole hiatus maxillaris of the upper jaw bone, for this is essentially narrowed by the overlapping of the neighboring bones, namely, by the pars perpendicularis oss. palatini from behind, the proc. maxillaris conchae nasalis inferioris from below, the proc. ethmoidalis conchae nasalis inferioris and the proc. uncinatus oss. ethmoidalis in the middle. The actual opening lies lateralward from the proc. uncinatus at the bottom of a narrow oblong fossa ***(infundibulum ethmoidale)***, which extends along the proc. uncinatus upward and forward, widens like a funnel and opens above into the sinus frontalis, but in addition receives the openings from the anterior ethmoidal cells; besides this connection between the frontal and nasal cavities there is also a second just medianward from the processus uncinatus. Projecting downward into the infundibulum ethmoidale from the outside there is usually a vesicular ethmoidal cell, the ***bulla ethmoidalis;*** the narrow sickle-shaped slit between this and the upper margin of the proc. uncinatus, the entrance to the infundibulum, is called the ***hiatus semilunaris***.

Into the ***meatus nasi superior*** open the middle and posterior ethmoidal cells.

Above the ***recessus sphenoethmoidalis*** the sinus sphenoidalis opens from behind by means of the apertura sinus sphenoidalis.



78. Nasal cavity, *cavum nasi,*

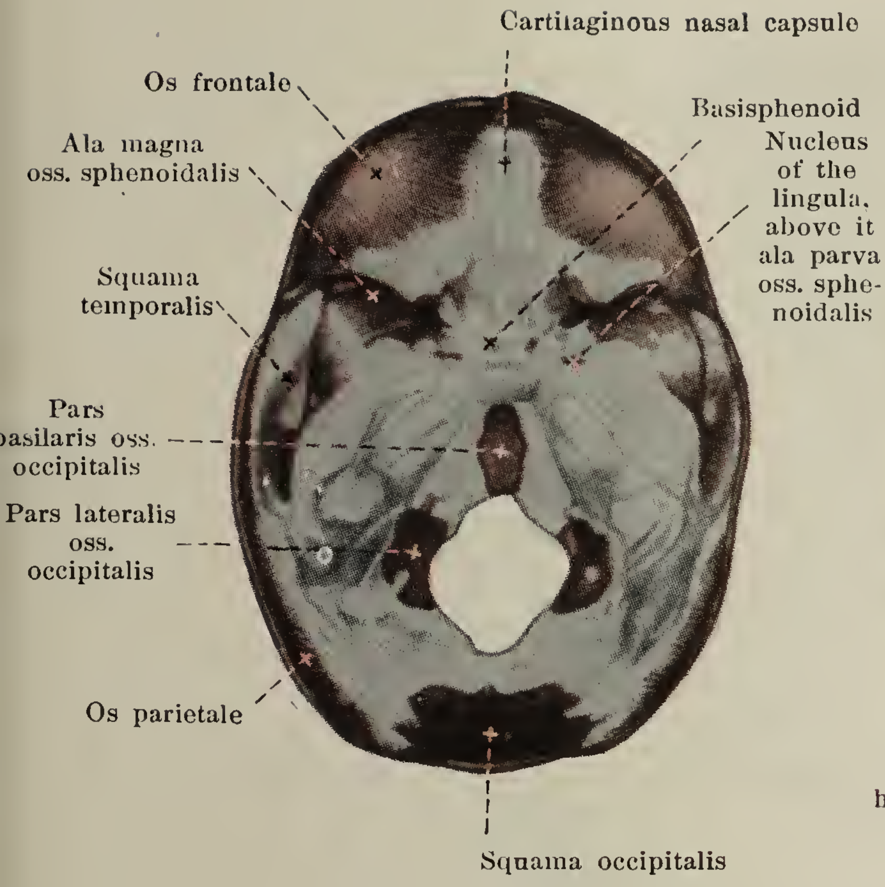
bony nasal septum, *septum nasi osseum*, from the left.

The ***upper*** narrowest ***wall*** of the **nasal cavity** (see also Figs. 75—77) is formed by the lamina cribrosa oss. ethmoidalis; the **lower**, broader **wall** by the slightly concave upper surface of the processus palatini maxillae and the partes horizontales oss. palatin..

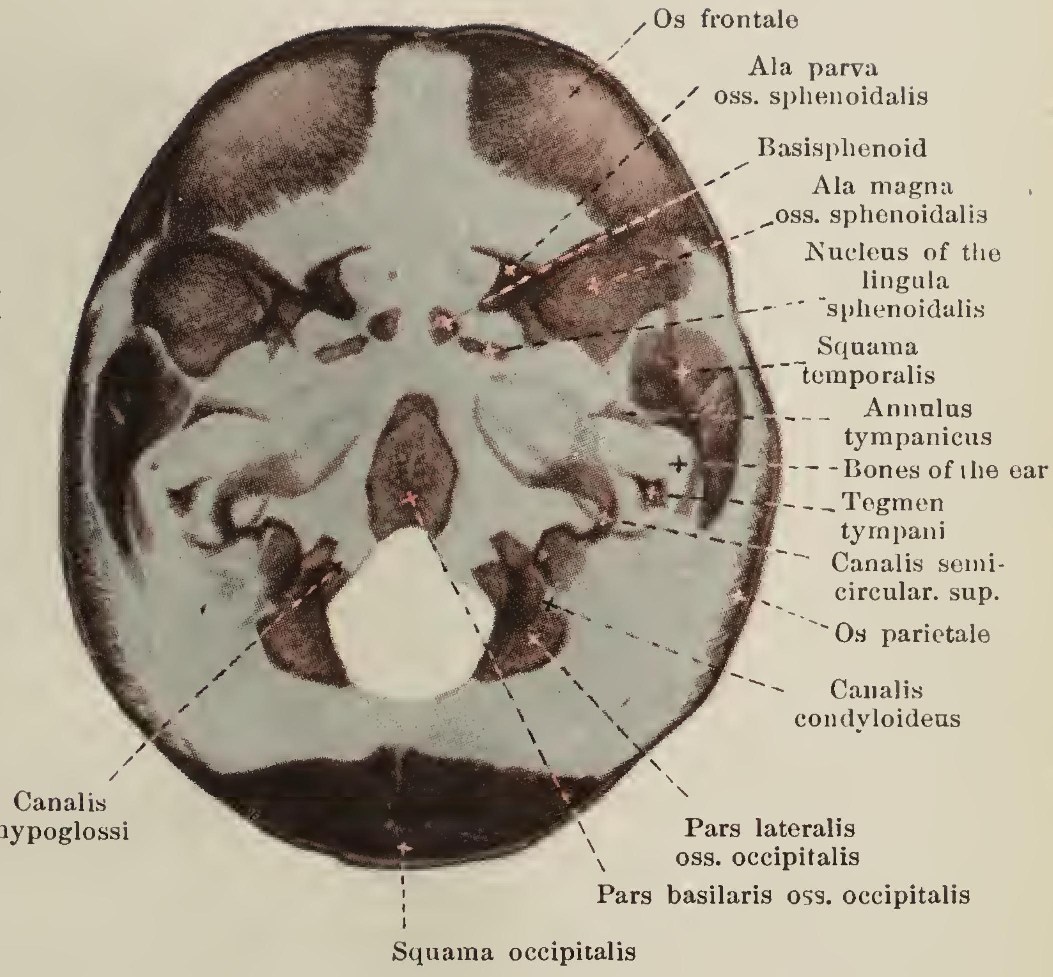
The ***anterior wall*** (see also Figs. 59, 76 and 77) of the nasal cavity proper is bony above only and is there formed by the spina frontalis of the pars nasalis oss. frontalis and the ossa nasalia; below it presents the *apertura piriformis* (O. T. anterior nares), opening toward the facial surface. This is "pear-shaped", narrow above, broad below and is surrounded above by the free margins of the ossa nasalia, lateralward by the incisurae nasales of the upper jaw bones, below by the ossa incisiva and the spina nasalis anterior.

The ***septum nasi osseum*** *(bony nasal septum)* (see also Fig. 75), which, within, subdivides the nasal cavity, lies in the median plane and is usually somewhat deflected toward one side or the other. This deviation, however, is never met with at the posterior margin. The septum begins in front, behind the apertura piriformis, by a deep notch which is filled up by the cartilago septi nasi, ends free behind at the posterior boundary of the nasal cavity and otherwise extends without essential interruption from the upper to the lower wall. Its upper part is formed by the lamina perpendicularis oss. ethmoidalis, the lower by the vomer. Above it unites in front with the spina frontalis of the pars nasalis oss. frontalis and with the lamina cribrosa oss. ethmoidalis, behind with the crista sphenoidalis and the rostrum sphenoidale; below it lies on the crista nasalis of the united maxillary and palate bones.

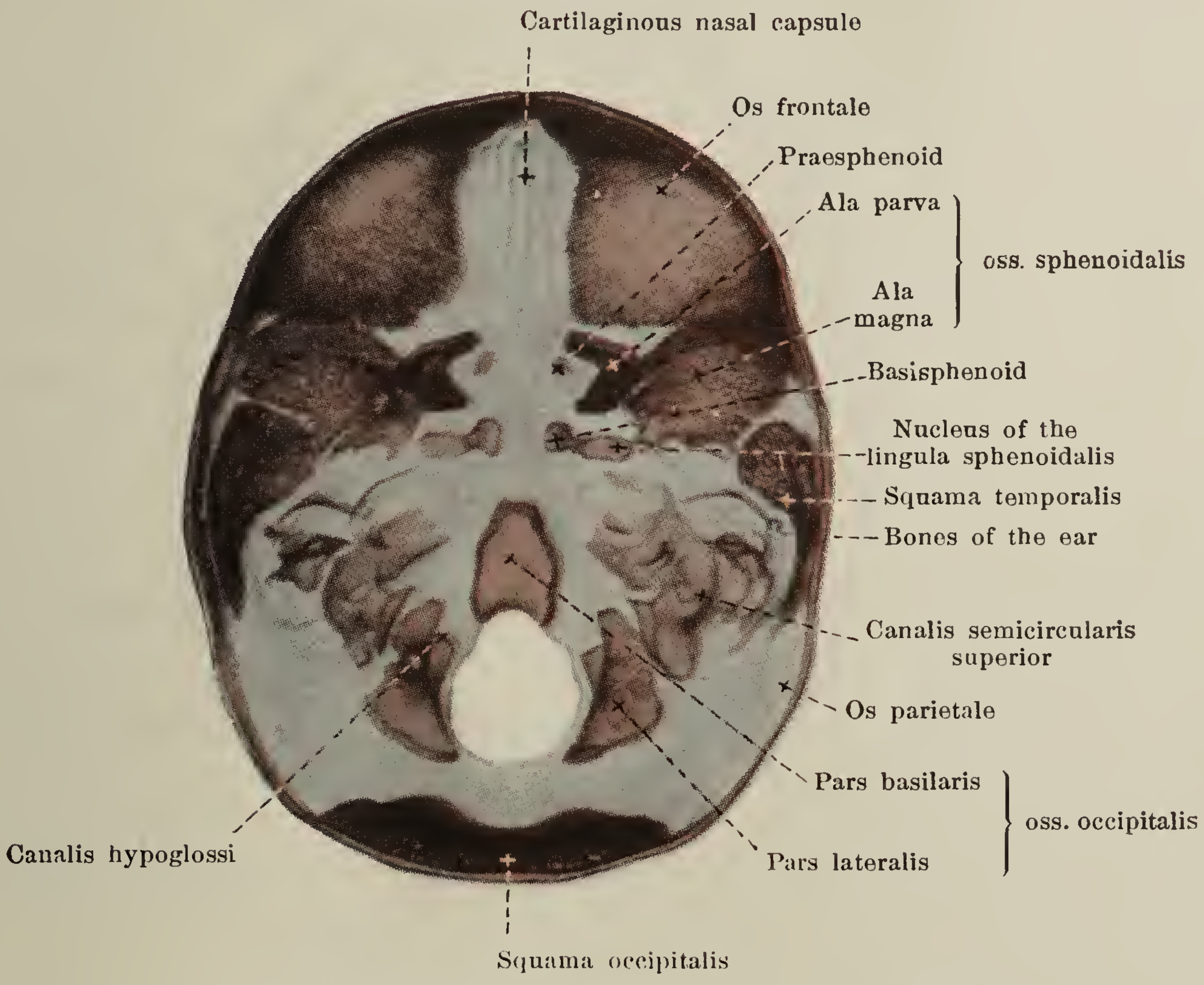
The nasal cavity is connected on its upper wall by the openings of the lamina cribrosa with the skull cavity and by the foramina ethmoidalia with the orbit; on its lateral wall by the canalis nasolacrimalis with the orbit, by the foramen sphenopalatinum with the fossa pterygopalatina; on its anterior wall by the foramina nasalia with the anterior facial surface; on its lower wall by the canalis incisivus with the mouth.


Cartilaginous nasal capsule
Os frontale
Basisphenoid
Ala magna oss. sphenoidalis
Nucleus of the lingula, above it ala parva oss. sphenoidalis
Squama temporalis
Pars basilaris oss. occipitalis
Pars lateralis oss. occipitalis
Os parietale
Squama occipitalis

79. Fetus 14 cm long (4 months).


Os frontale
Ala parva oss. sphenoidalis
Basisphenoid
Ala magna oss. sphenoidalis
Nucleus of the lingula sphenoidalis
Squama temporalis
Annulus tympanicus
Bones of the ear
Tegmen tympani
Canalis semicircular. sup.
Os parietale
Canalis condyloideus
Canalis hypoglossi
Pars lateralis oss. occipitalis
Pars basilaris oss. occipitalis
Squama occipitalis

80. Fetus 18 cm long (4 months).

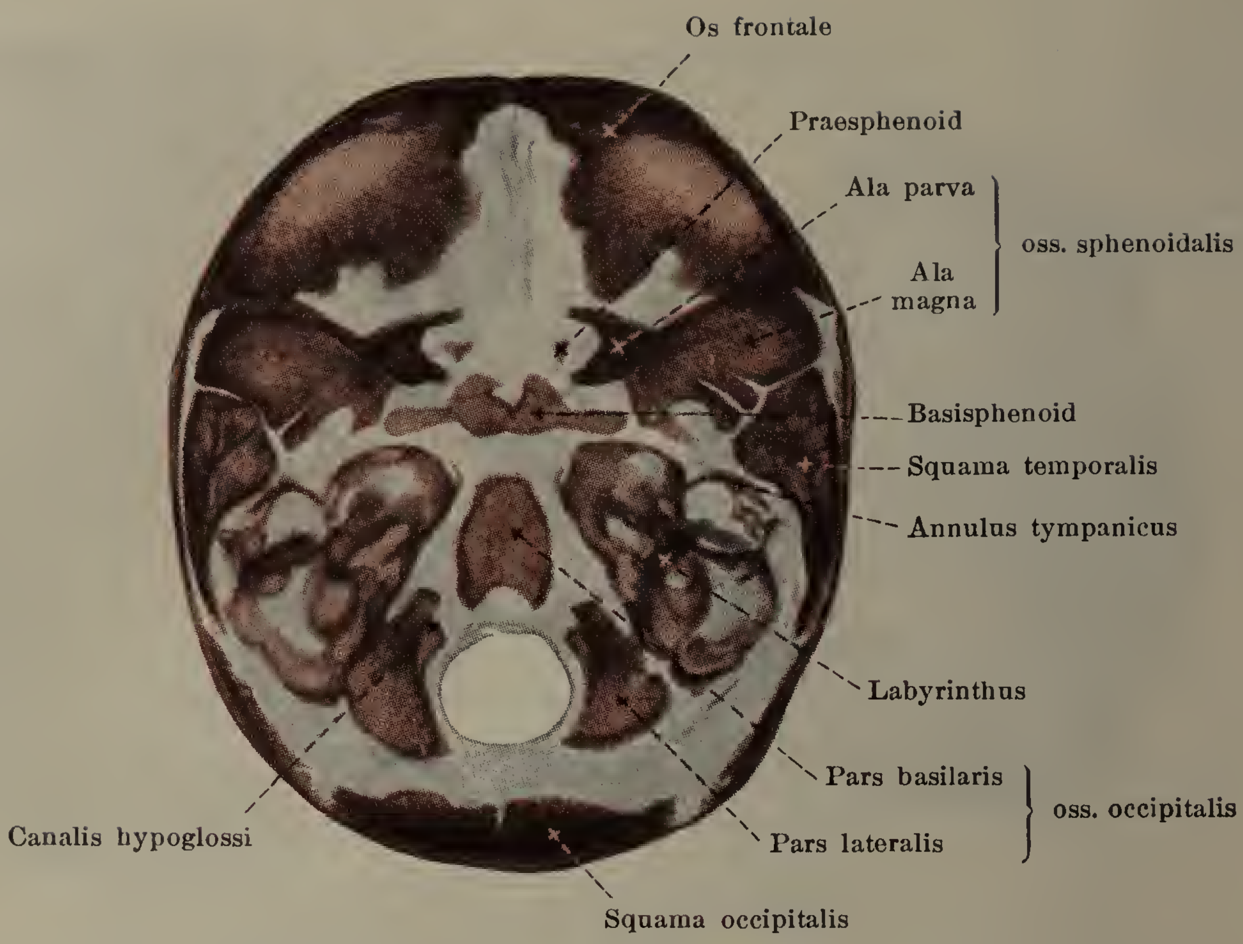


81. Fetus 12 cm long (4 months).

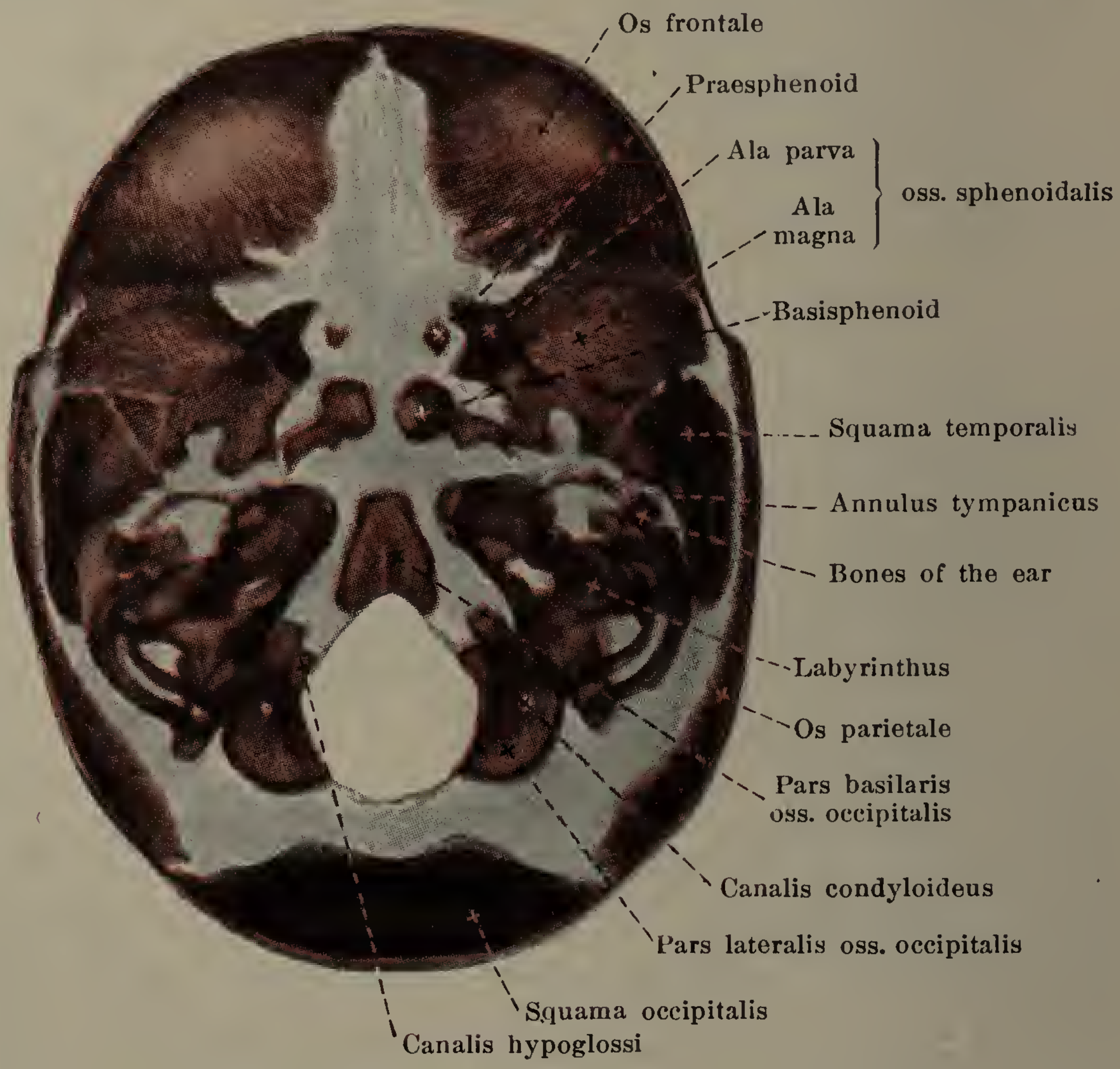
79—84. Bases of Fetal Skulls,

after removal of the roof of the skull, as seen from above. (Magnification: 3:2.)

(The bone substance it colored red, the base transparent.)



82. Fetus 14 cm long (4 months).

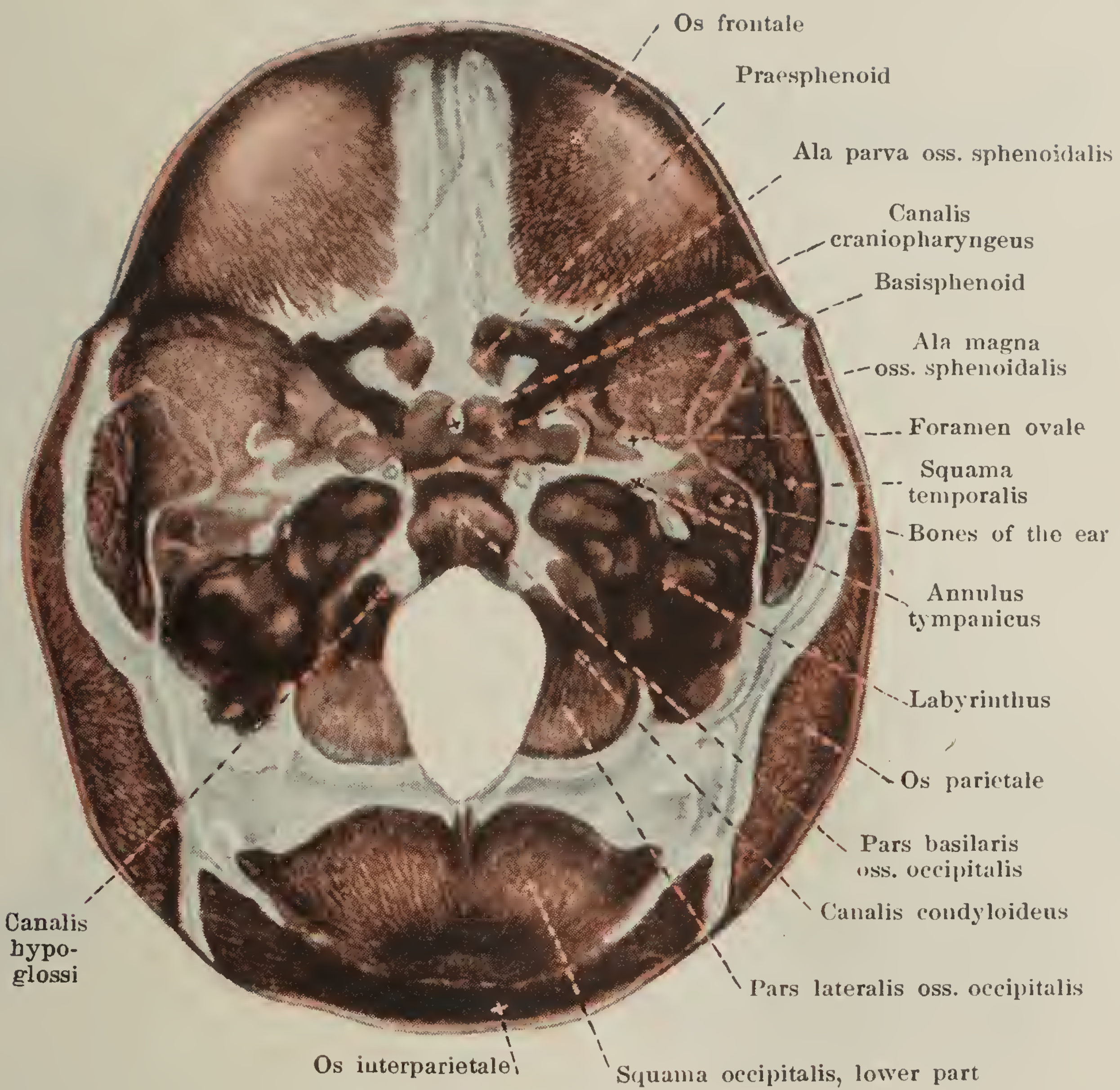


83. Fetus 19 cm long (beginning of 5th month).

79—84. Bases of Fetal Skulls,

after removal of the roof of the skull, as seen from above. (Magnification: 3 : 2.)

(The bone substance is colored red, the base transparent.)



84. Fetus 28 cm long (6 months).

79—84. Bases of Fetal Skulls,

after removal of the roof of the skull, as seen from above.

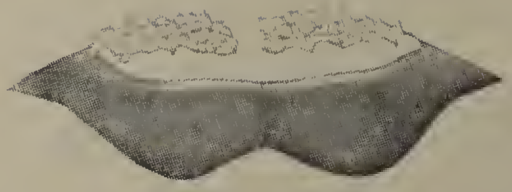
Magnification 3 : 2.

(The bone substance is colored red, the base transparent.)

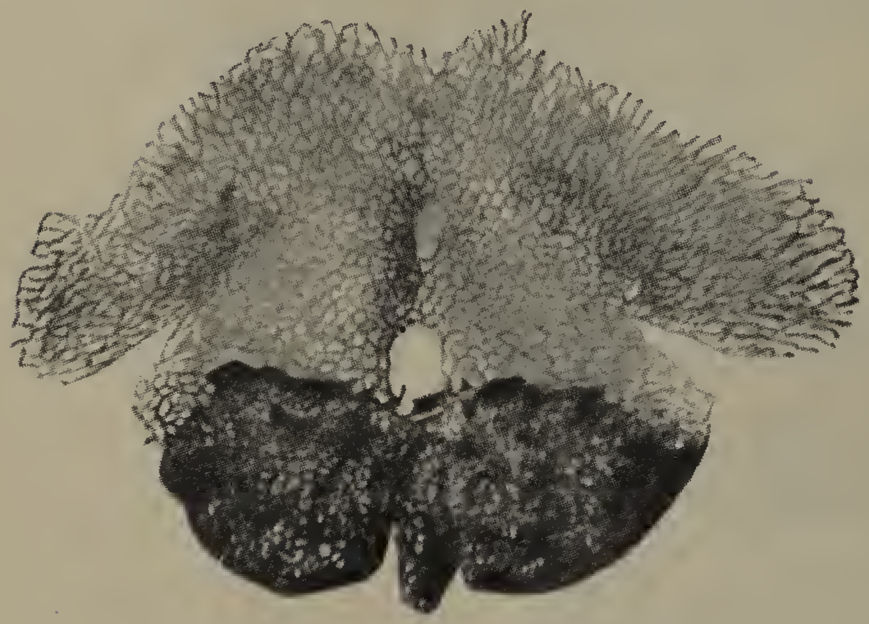
Development of the Bones of the Skull.

Every bone in the body develops from at least one *bone nucleus* or *center of ossification.* The localisation of these bone nuclei is subject to but slight variations; their time of appearance on the other hand does show great individual variations.

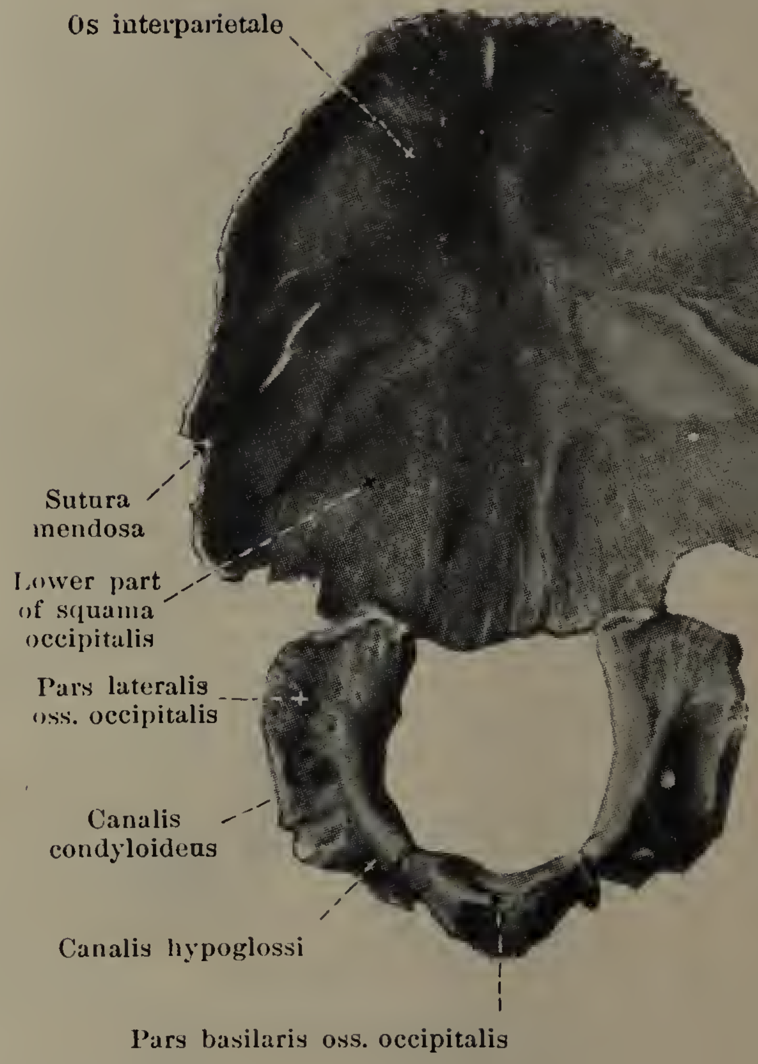
Of the bones of the skull, a part of them is preceeded in their development by the deposition of cartilage (the so-called *cartilage bones, or primordial bones*) and arises from a more or less connected cartilaginous mass, the *primordialcranium,* which includes most of the bones of the base of the skull; namely, the os occipitale (without the upper part of the squama), the os sphenoidale (not including the lamina medialis of the processus pterygoideus), the os temporale (without the squama temporalis and the pars tympanica), the os ethmoidale, the concha nasalis inferior, parts of the mandibula, the os hyoideum, and the tympanic ossicles. The upper portion of the squama occipitalis, the lamina medialis of the processus pterygoideus oss. sphenoidalis, the squama temporalis and the pars tympanica oss. temporalis, the greater portion of the mandibula, and all the rest of the skull bones not named above are developed as *fibrous-tissue bones* or *membrane bones,* differing from the above cartilage bones in that they are developed by the formation of bone from the connective tissue. The fibrous tissue covers the brain above, in front, behind, and on the sides like a *membranous skull capsule.*



85. Occipital squama of a fetus 5 cm long,
(about 10 wks.), after Ranke.
Magnif.: 5 : 1.

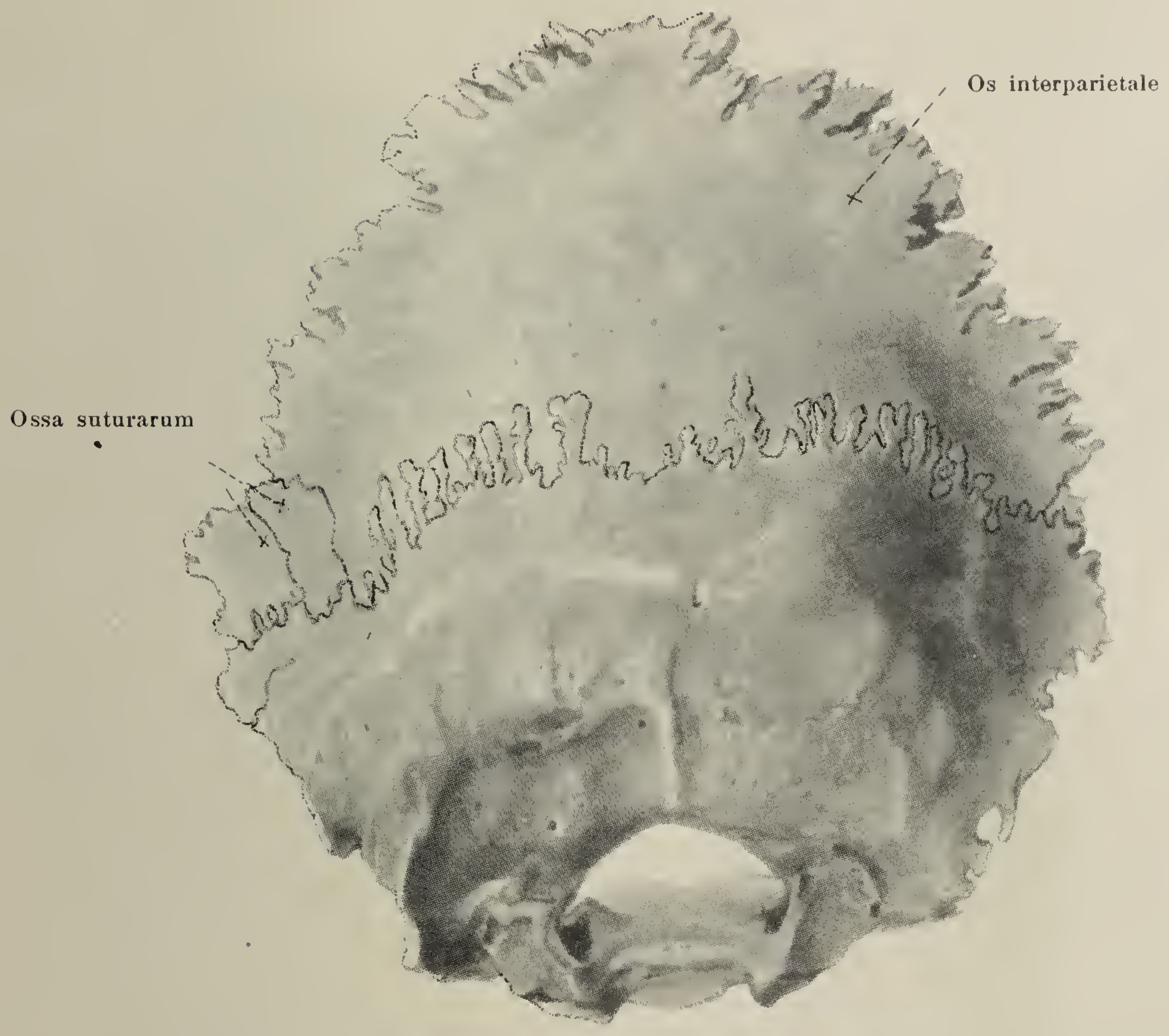


86. Occipital squama of a fetus 7.5 cm long,
(about 13 wks.) viewed from behind.
Magnif.: 4 : 1.


Os interparietale
Sutura mendosa
Lower part of squama occipitalis
Pars lateralis oss. occipitalis
Canalis condyloideus
Canalis hypoglossi
Pars basilaris oss. occipitalis

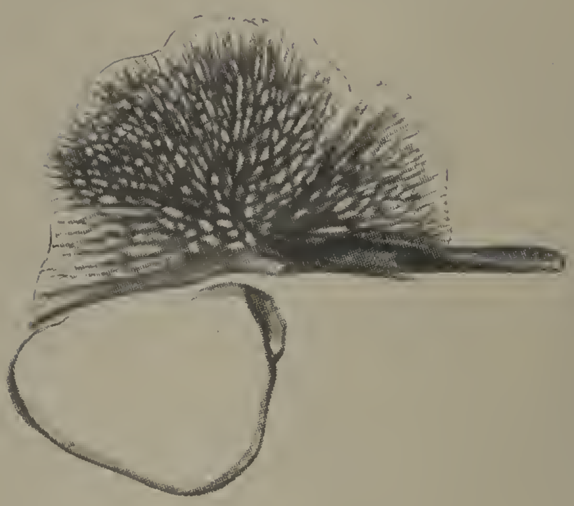
87. Occipital bone of a 7 months fetus,
viewed from the front.
Magnif.: 1 : 1.

The *os occipitale* (see Figs. 79—87) arises in five parts: the pars basilaris, two partes laterales, and the lower and upper parts of the squama. The latter portion is membranous in origin, the rest is cartilage bone. The pars basilaris develops from a bone nucleus in the 10th week, each pars lateralis from one in the eighth week. The lower part of the squama begins to ossify in the sixth to seventh week from two nuclei which, in the eighth to ninth week, merge together into a transverse elongated strip. In the upper part of the squama appears shortly afterward another symmetrical pair of nuclei which quickly combine with one another and again with the upper margin of the first pair; in its lateral section a wedge-shaped incising region of bone substance remains free, diminishes at birth to a cleft and can be detected later on as a suture *(sutura mendosa)*. In a few isolated cases a further bone nucleus or two appear above those mentioned which can fuse with one another and with others or remain separated, and thus lead to the formation of a uniform or divided *os interparietale* (see Fig. 87a). The canalis hypoglossi begins to appear as a groove which notches the pars lateralis from before. At the time of birth the os occipitale consists of four pieces. The fusion of the squama with the partes laterales takes place in the 1st—4th years; that of the latter with the pars basilaris in the 3rd—6th year.



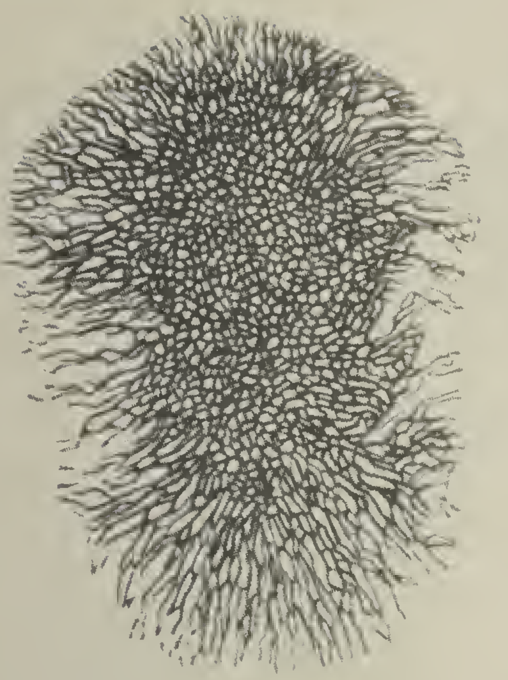
87a. Occipital bone with os interparietale, (*Var.*), from behind.

The *os sphenoidale* (see Figs. 79—84) develops from seven pairs of nuclei; at the end of the second month there appears between the foramen rotundum and foramen ovale a nucleus for the greater wing, from which also the lamina lateralis of the proc. pterygoideus ossifies; in the ninth week, there appears at the lateral border of the foramen opticum a nucleus for the lesser wing. The body of the sphenoid ossifies from two pairs of nuclei lying behind each other; the posterior pair forms the *basisphenoid* and appears in the third month in relation to the floor of the sella turcica, the anterior pair forms the *praesphenoid* and appears a little later; next to the basisphenoid there arises at the same time a small nucleus for the lingula sphenoidalis and the adjacent part of the sulcus caroticus, which soon fuses with the basisphenoid. The nuclei of the basisphenoid unite in the fourth month, at first in their dorsal parts. The region in front of this connecting bridge (see Fig. 84) is early traversed by Rathke's pouch of the primitive oral cavity, which then contracts and helps to form the cerebral hypophysis (see p. 655); at this place the ossification takes place later and in some cases not at all, so that an almost vertical canal, *canalis craniopharyngeus*, will be found. In the fourth month, on each side, the nucleus of the lesser wing merges into the presphenoid; the two nuclei of the presphenoid unite in the eighth month with each other and at the same time (at first only laterally) with the basisphenoid. The lamina medialis of the proc. pterygoideus receives a special nucleus in the second month, and in the fourth month fuses with the nucleus of the greater wing. These nuclei of the laminae mediales of the proc. pterygoidei are membranous in origin as are also small distinct nuclei on each side at the tips of the wings; the rest of the nuclei develop in cartilage. At birth the bone consists of three parts; one part on each side formed by the greater wing with the whole proc. pterygoideus and the third consisting of the other nuclei fused with each other; these three parts grow together in the first year. The concha sphenoidalis originates from several nuclei in the primordialcranium after the fifth month. The sinus sphenoidalis, which begins through separation from the main nasal cavity, has the size of the head of a pin at the time of birth; at the beginning of the fourth year it begins to grow and extends in the 9th—12th year into the body of the sphenoid bone.

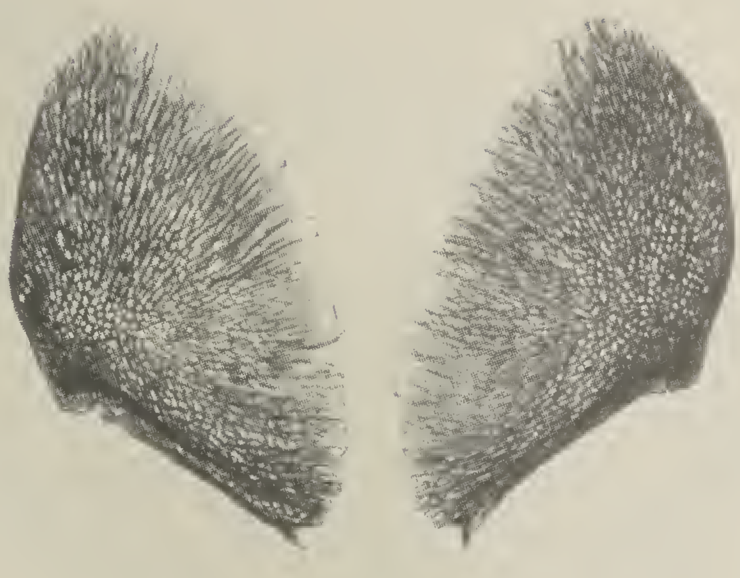


88. The right squama temporalis and annulus tympanicus of a fetus 18 cm long (4 months). Magnification 3:1.

The *os temporale* (see also Figs. 15, 17 and 79—84) shows even at birth its origin from three bones, which correspond to the squama, the pars tympanica, and the pars petrosa; it encloses, moreover, the ossicles of the internal ear, and joins with the processus styloideus which is to be regarded as a separate element. The squama and the pars tympanica are membrane, the other parts are cartilage bones. The squama acquires a nucleus near the root of the proc. zygomaticus about the end of the second month, and this nucleus later on grows down also behind the pars tympanica. The nucleus of the pars tympanica appears in the beginning or middle of the third month in the connective tissue surrounding the border of the tympanum and forms at first a ring almost completely closed' and only open above, the *annulus tympanicus* into which the drum membrane in inserted; the free ends of the annulus tympanicus grow together at the time of birth with the squama. See further p. 16. The pars petrosa originates through the ossification of the *cartilaginous labyrinthine capsule;* it begins in the fifth month from several nuclei, and at the end of the sixth month the labyrinth is completely enclosed in bone. The tegmen tympani ossifies partly as cartilage bone, partly as membrane bone. The proc. styloideus arises from the upper end of the cartilage of the second visceral arch, and ossifies from two centres, of which the upper one appears shortly before, the lower one after birth; the upper nucleus or centre fuses soon with the pars petrosa and the pars tympanica, while with the lower centre of ossification it does not unite until middle life. The tympanic ossicles begin to ossify in the second half of the fifth month; the malleus (with the exception of the proc. anterior which is membranous in origin) and the incus are formed each from a nucleus in the upper end of the cartilage of the first visceral arch, the stapes from a nucleus in the upper end of the cartilage of the second visceral arch. The cellulae mastoideae begin to appear at puberty.



89. The right parietal bone of a fetus about 9 cm long (about 12 wks.). Magnif.: 3:1.



90. Frontal bone of a fetus about 4 months old, viewed from the front. Magnif.: 3:1.

The *os frontale* (see also Figs. 79—84) arises as a membrane bone from a right and a left centre of ossification, each of which, about the end of the second month, appears near the margo supraorbitalis; there are moreover several accessory nuclei or centres on each side which appear before birth and which soon fuse with the main centre. The two halves approach each other, but unite only after birth (in the eighth year). See further p. 17. The sinus frontales first appear at the end of the first year; their development in the main is completed at puberty.

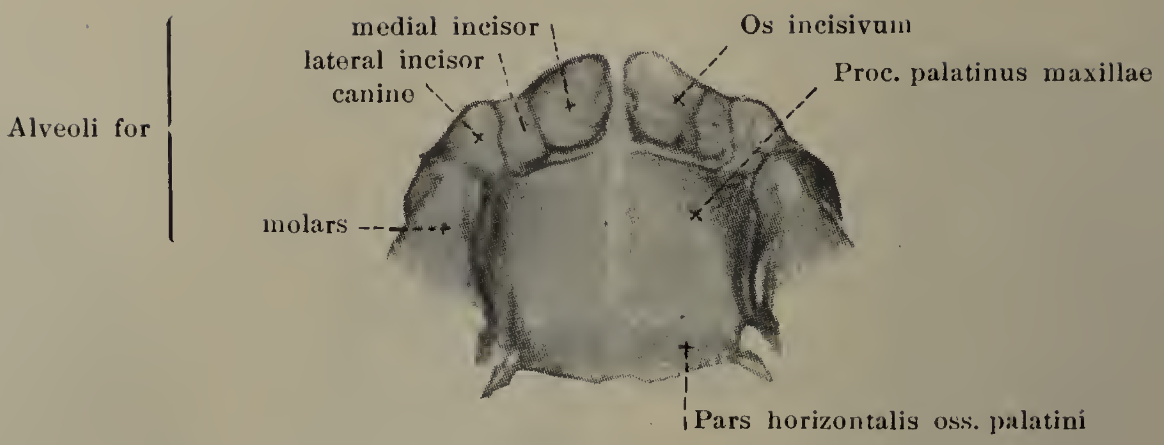
The *os parietale* (see also Figs. 79—84) is a membrane bone originating usually from two centres of ossification, an upper and a lower one which first appear about the end of the second month and very soon fuse together.

The *os ethmoidale* develops as a cartilage bone from several centres of ossification arising in the *cartilaginous nasal capsule* which surrounds the nasal cavity above and laterally and shows a division in the median line. About the end of the fifth month there appears a nucleus on each side in the lateral walls of the nasal capsule, from which the lamina papyracea develops and from which the conchae ossify. At the end of the first year a nucleus appears in the upper part of the cartilaginous nasal septum; from this the crista galli and thel amina perpendicularis ossify. In the sixth year the two lateral and the middle parts of the os ethmoidale unite with each other as well as with the accessory centres of ossification which appear in the crista galli and the lamina cribrosa after birth. The cellulae ethmoidales arise from the fact that between and beside the conchae folds of the nasal mucous membrane are formed into which bone laminae grow after birth. The ossification of the os ethmoidale is not completed until the sixteenth year.

The *concha nasalis inferior* develops from a nucleus which first appears as a cartilage bone during the second half of fetal life in the lower portion of the lateral wall of the nasal capsule.

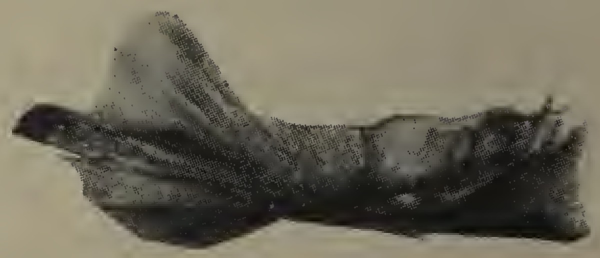
The *os lacrimale* is membranous in origin arising from a nucleus on the outer surface of the cartilaginous nasal capsule in the third month.

The *os nasale* is a membrane bone which is formed in the anterior part of the cartilaginous nasal capsule, from a nucleus which first appears at the end of the second month. The cartilaginous substratum of the bone is absorbed after birth.



91. Palate of a fetus 19 cm long (beginning of 5th month), seen from below. Magnif. 2:1.

92. Right half of the lower jaw of a fetus 6.3 cm long (12th week). Magnif.: 4:1.



92. Right half of the lower jaw of a fetus at the end of the 5th month. Magnif.: 2:1.

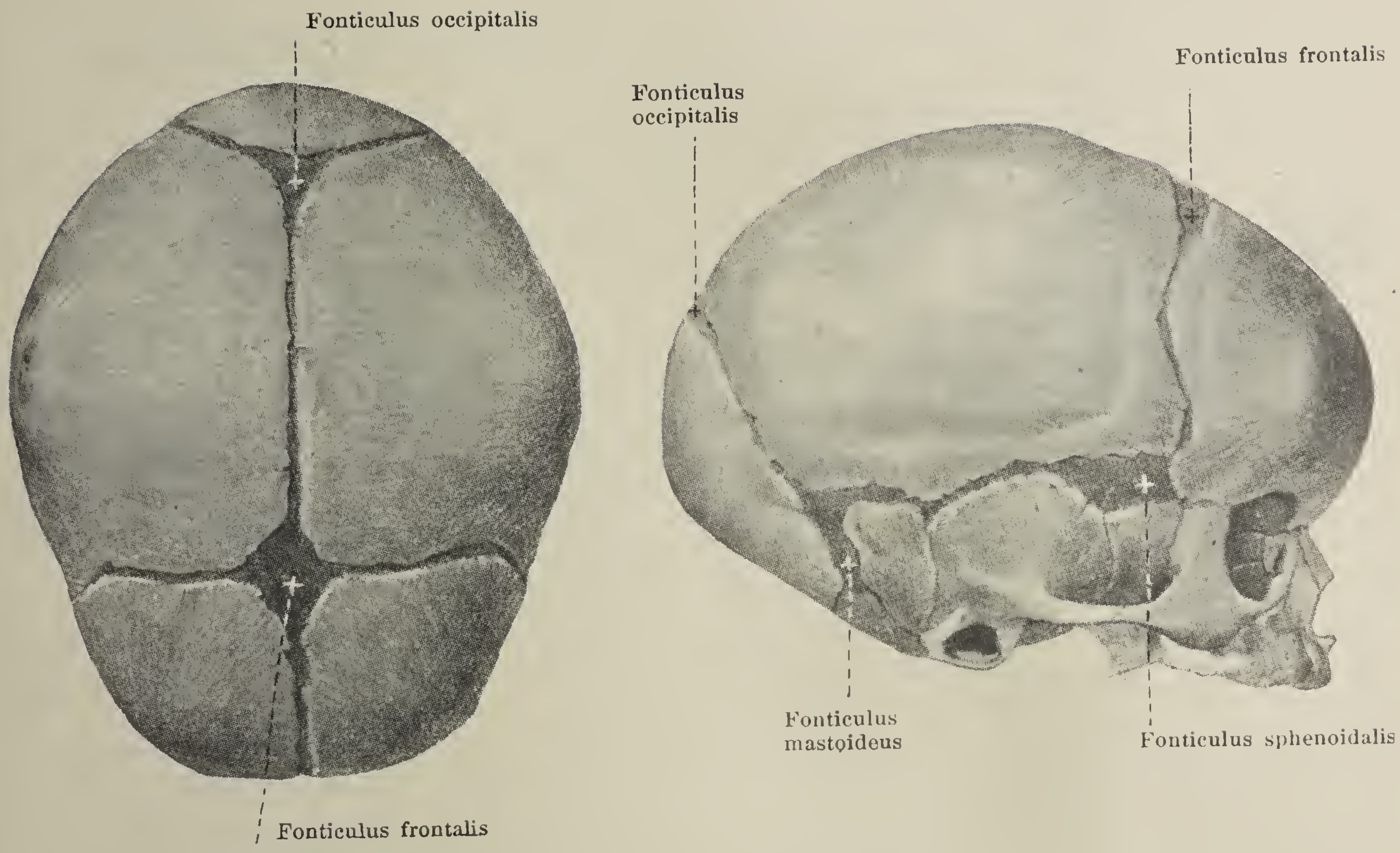
The *vomer.* In the eighth week there appears a centre of ossification on each side of the cartilaginous nasal septum close to the posterior border; these two centres of ossification unite at the lower margin of the septum and further grow together from behind forwards, while the cartilage between them is gradually absorbed. The vomer is therefore a purely membranous bone. Its development is completed at puberty.

The *maxilla* develops as a membranous bone in two parts, a medial which includes the region of the two incisor alveoli *(os incisivum)*, and a lateral corresponding to the remaining portion. The os incisivum, which helps to delimit the apertura piriformis through a protuberance directed frontally, receives a nucleus at the end of the sixth week; the remaining part acquires one, or (according to some) more nuclei at the same time; both parts unite about the end of the second month. The sinus maxillaris appears first as a flat groove on the medial surface of the maxilla in the fourth fetal month.

The *os palatinum* is developed as a membrane bone from a nucleus which appears in the eighth week in the angle between the horizontal and vertical parts.

The *os zygomaticum* develops as a membrane bone from a nucleus in the eighth week. Not rarely there are two or three nuclei which for the most part fuse together, but occasionally may remain distinct *(os japonicum)* (not shown in the figure).

The *mandibula* develops for the most part as a membrane bone on the lateral side of *Meckel's cartilage* located in the first embryonic visceral arch, originating from a nucleus on each side, which first makes its appearance in the seventh week, and from which the main portion of the body and of the rami develops. Only the section of Meckel's cartilage in the neighborhood of the incisors is ossified directly into bone. Besides this, there arises also at the tip of the processus coronoideus, of the proc. condyloideus, and at the anterior ends of the two halves of the jaw as well as at the border of the alveoli (independently of Meckel's cartilage) cartilage tissue which is transformed into bone. All these accessory bony formations soon merge into the chief bone. In the connective tissue between the two halves of the jaw there appear shortly before or after birth one or more small ossicles *(ossicula mentalia)*, which quickly grow together with the corresponding half of the jaw. The two halves of the jaw unite in the first or second year.



94 and 95. Skull of the new born child. Magnification: 1:2.

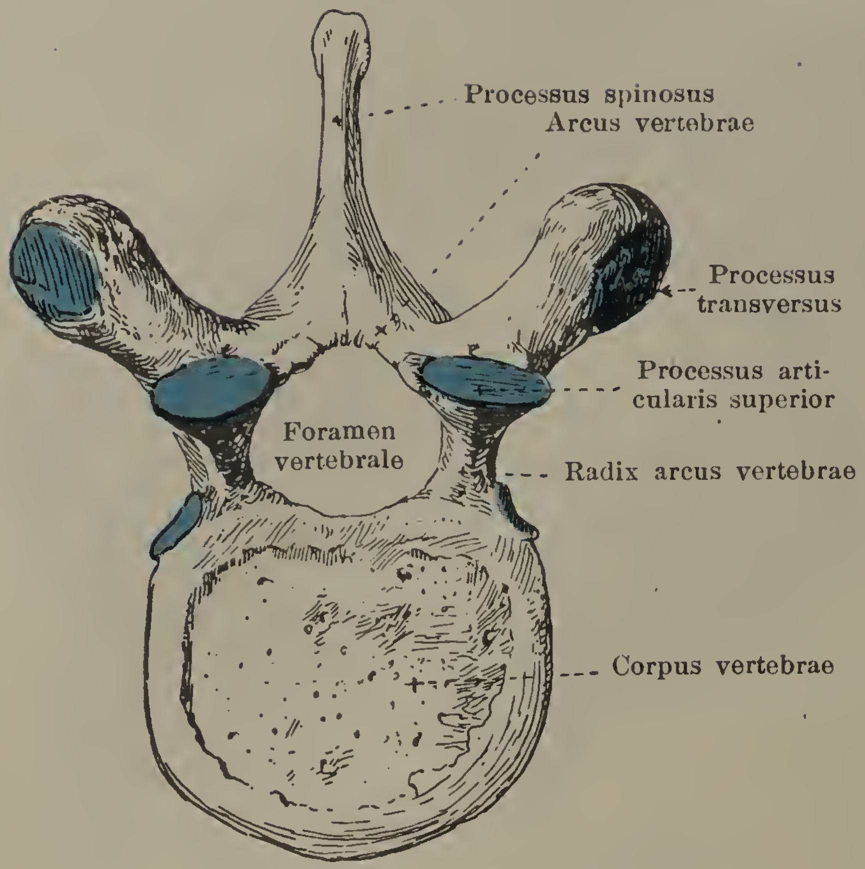
View from above. View from the right.

The *os hyoideum* develops from cartilage, viz. the small horn from the second, the great horn from the third visceral arch cartilage, the body from a ventral connection of the united second and third visceral arch cartilage. It ossifies from five centres, of which one is in the body, and one in each of the horns; the centres of ossification of the body and of the great horns appear at the end of fetal life, those of the small horns only ofter birth.

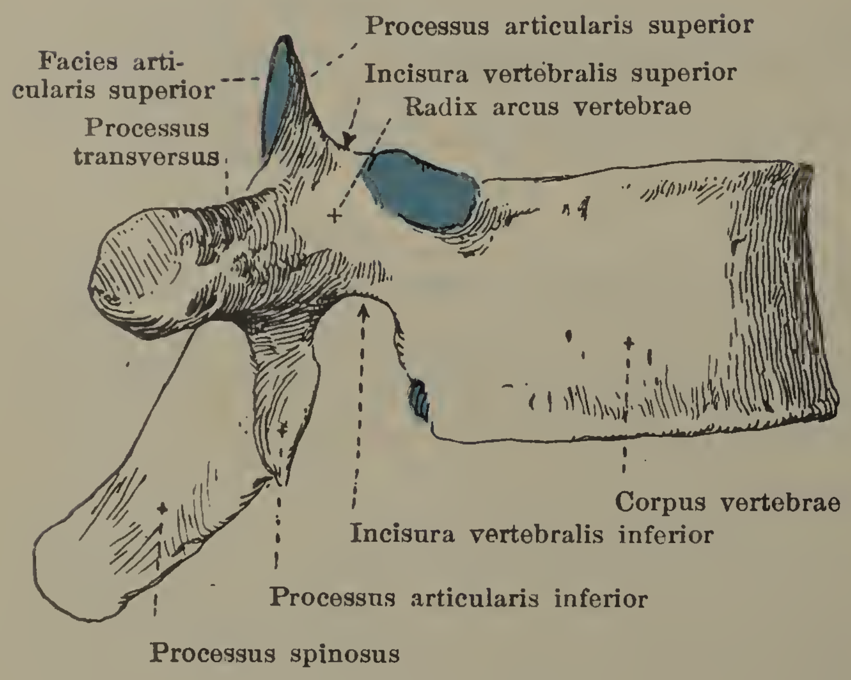
Fontanelles. In the *membranous skull capsule* (see page 67) there are found at birth unossified portions at the places where the bones grow together; and more particularly narrow strips along what are to be later the skull sutures, and large spots where several bones come together. These latter regions are called the **fonticuli** *(fontanelles)* lie at the angles of the ossa parietalia and are six in number; two unpaired and two paired. Of the unpaired the largest, quadrangular, *fonticulus frontalis [major]* (similar to a kite, sharp angle towards the front) lies at the junction of the suturae coronalis, sagittalis and frontalis, the small, triangular *fonticulis occipitalis [minor]* at the apex of the squama occipitalis, where the suturae lambdoideae and the sutura sagittalis meet. Of the paired fontanelles, the anterior, oblong *fonticulus sphenoidalis* lies at the apex of the large wing of the sphenoid, bounded by the angulus parietalis of the ala magna oss. sphenoidalis, by the squama temporalis oss. temporalis, the angulus sphenoidalis oss. parietalis, and the squama frontalis oss. frontalis; the posterior, more irregular *fonticulus mastoideus* is situated below the angulus mastoideus oss. parietalis, enclosed by this, by the pars mastoidea oss. temporalis, and by the squama occipitalis oss. occipitalis. — The fontanelles usually close during the first, the fonticulus major not until the second half of the second year of life.

96 and 97. Vertebra, *vertebra*

(10th thoracic vertebra, somewhat schematically represented).



from above


Processus articularis superior
Facies articularis superior
Incisura vertebralis superior
Radix arcus vertebrae
Processus transversus
Corpus vertebrae
Incisura vertebralis inferior
Processus articularis inferior
Processus spinosus

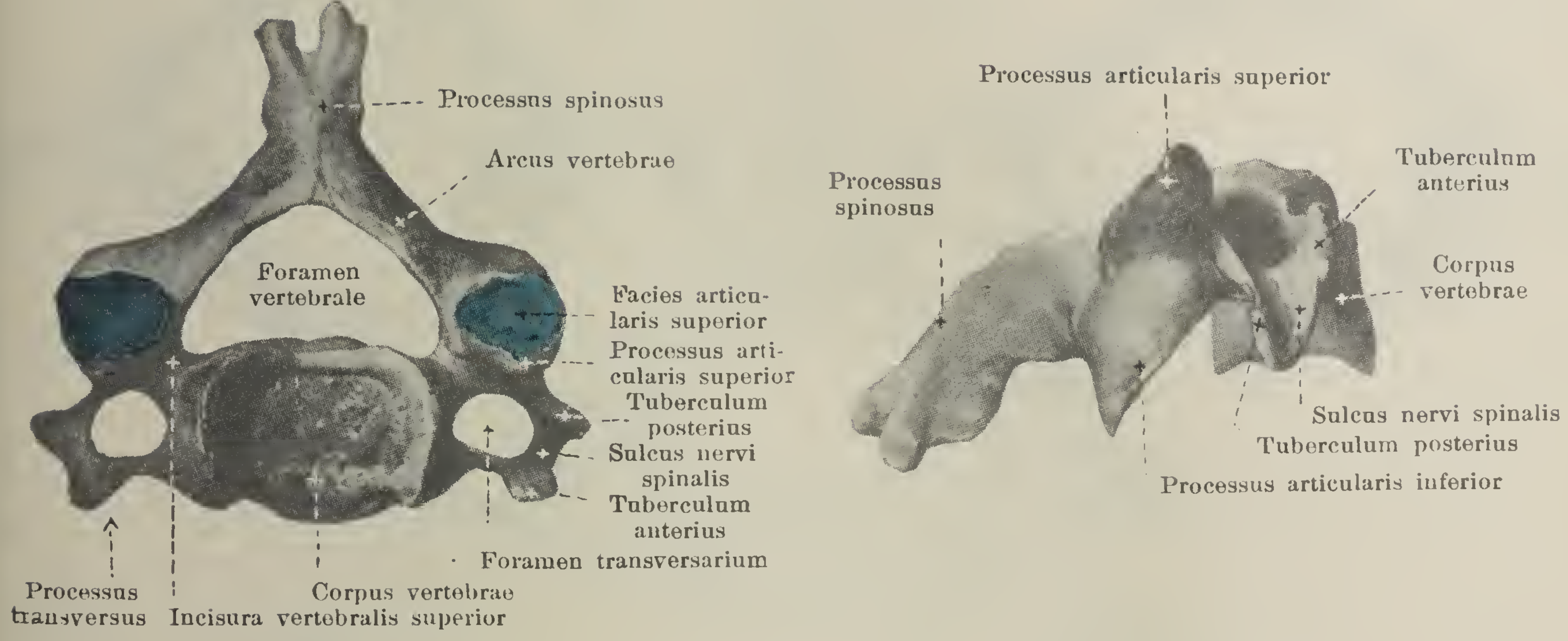
from the right

The **columna vertebralis** *(vertebral column or spine)* extends from the base of the skull as far as the lower end of the trunk. It consists of 33—34 *vertebrae* superimposed upon one another; these are divisible, from above downwards, according to the regions in which they lie, into *vertebrae cervicales*, *vertebrae thoracales*, *vertebrae lumbales*, *vertebrae sacrales*, and *vertebrae coccygeae.*

Each **vertebra** is approximately ring-shaped and consists of an anterior, thick *body*, *corpus vertebrae*, and a feebler, flat *arch*, *arcus vertebrae;* the two include between them a wide opening, the *foramen vertebrale.* The sum of all the vertebral foramina forms the *canalis vertebralis (spinal canal).* (For development see p. 98.)

The **corpus vertebrae** *(vertebral body)* has the form of a short cylinder and possesses an upper and a lower surface which are nearly parallel and fit into the corresponding surfaces of the neighboring vertebrae; these surfaces are somewhat rough, flat or slightly depressed, and firmly fused with the appertaining intervertebral disc. The anterior and the lateral surfaces are convex in the horizontal, somewhat concave in the vertical direction; the posterior surface, which forms the anterior boundary of the foramen vertebrale, is approximately flat and presents especially large foramina nutricia.

The **arcus vertebrae** *(vertebral arch)* begins at the upper part of the posterior surface of the corpus right and left by a narrow root, *radix arcus vertebrae* (O. T. pedicle); above this lies the shallower *incisura vertebralis superior*, below it the deeper *incisura vertebralis inferior;* the intervertebral notches of two adjoining vertebrae (with the intervertebral plate and with the capsulae articulares) unite to form one *foramen intervertebrale* (for the passage of vessels and nerves) (see Fig. 108). Close behind the upper incisura, passing upward on each side is the *processus articularis superior* with the *facies articularis superior*, which generally looks backward; while extending downward behind the lower incisura is the *processus articularis inferior* with the *facies articularis inferior* which generally looks forward; between or in front of these, directed lateralward, projects the *processus transversus.* From the middle of the arcus, projecting backward, is seen the *processus spinosus.*

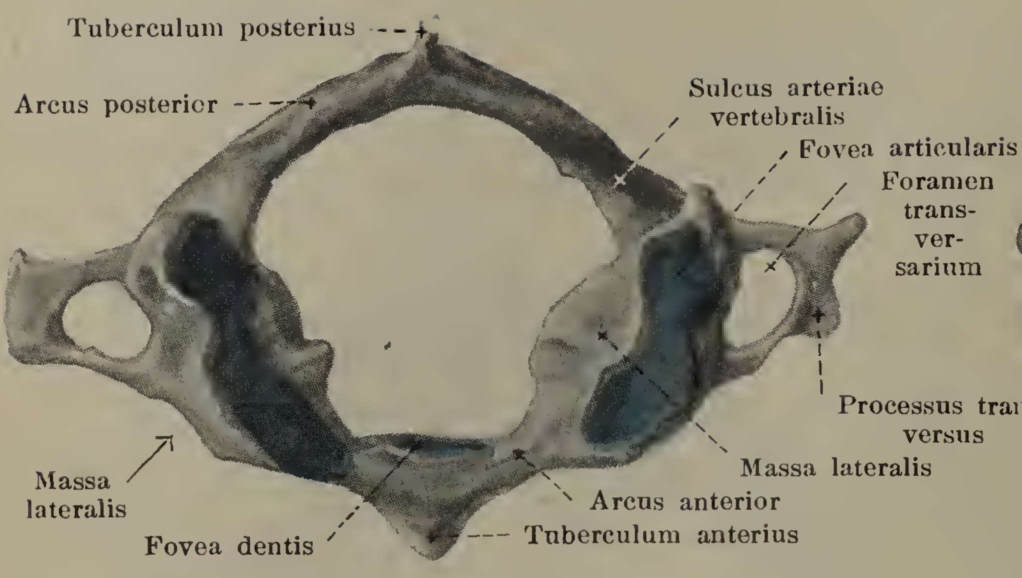


98 and 99. Fourth cervical vertebra,

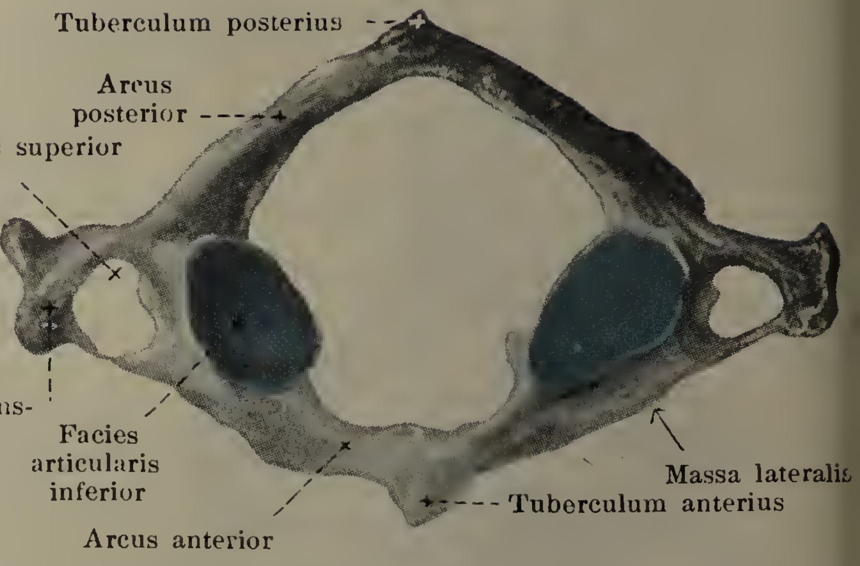
From above. *vertebra cervicalis IV.* From the right.

The *seven* vertebrae above the thoracic vertebrae (see p. 77) in the region of the neck are known as the **vertebrae cervicales** *(cervical vertebrae)* (see also Fig. 105). They have a low *body* which, as seen from above, is quadrangular with rounded angles. The bodies are of approximately the same height at the rear and in front. The upper surface is concave in frontal, slightly convex in sagittal direction, the lower exactly the reverse. The *foramen vertebrale* is very wide and triangular. The *processus articulares superiores et inferiores* are placed very obliquely; their *facies articulares* are irregular, slightly arched, the *superiores* look backward and upward, the *inferiores* forward and downward. The *processus spinosi* are usually short and split into two spurs. The form of the *processus transversi* is especially characteristic for the cervical vertebrae. These arise in front of the processus articulares, from the body and the radix arcus vertebrae, are short and directed lateralward. On the upper surface, each presents a deep groove, *sulcus nervi spinalis* (for the ramus anterior n. cervicalis), which runs out from the incisura vertebralis superior and separates, at the tip of the transverse process, the *tuberculum anterius* from the *tuberculum posterius.* In the region of the groove is situated also the *foramen transversarium* (in the upper six cervical vertebrae for the a. and v. vertebralis, in the 7th mostly only for the v. vertebralis). The part of the processus transversus situated in front of the foramen transversarium with the tuberculum anterius and the bone-bridge lying laterally of the foramen transversarium and forming the floor of the sulcus nervi spinalis is homologous with a rib and is accordingly also called the *processus costarius;* it may be so developed on the seventh cervical vertebra that it actually forms a *cervical rib* (see Fig. 117, No. 4). (For development see p. 98.)

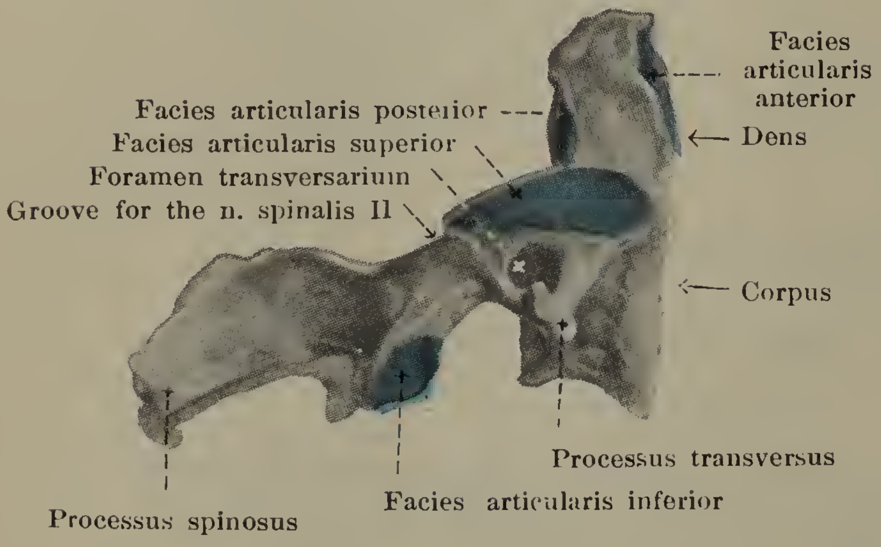
The first cervical vertebra, *atlas*, the second, *epistropheus*, and the seventh, *vertebra prominens*, differ in some respects markedly from the above description.



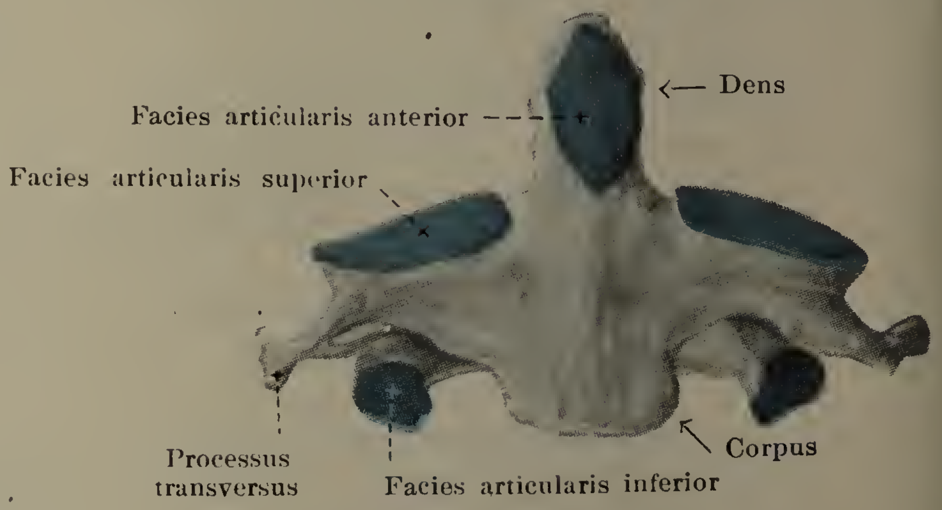
100. Atlas, from above.



101. Atlas, from below.

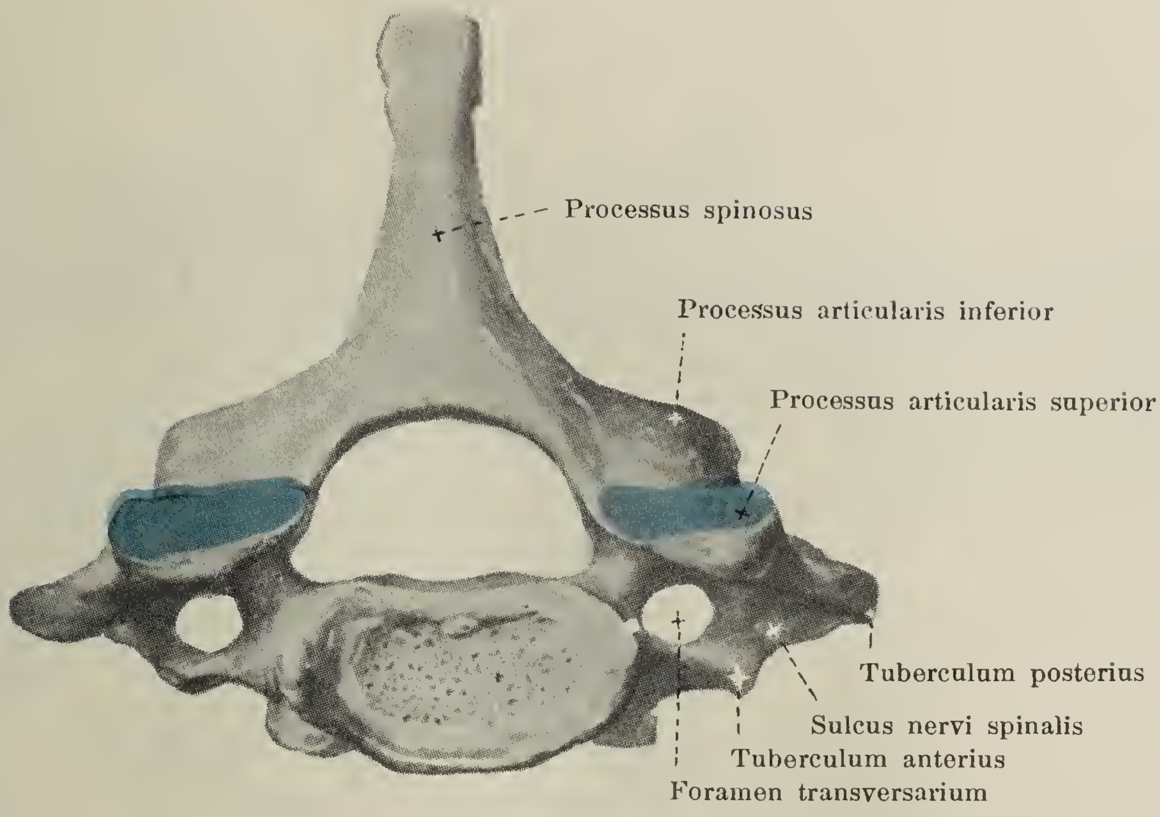

Facies articularis anterior
Facies articularis posterior
Facies articularis superior
Dens
Foramen transversarium
Groove for the n. spinalis II
Corpus
Processus transversus
Processus spinosus
Facies articularis inferior

102. Epistropheus from the right.


Dens
Facies articularis anterior
Facies articularis superior
Processus transversus
Facies articularis inferior
Corpus

103. Epistropheus, from in front.

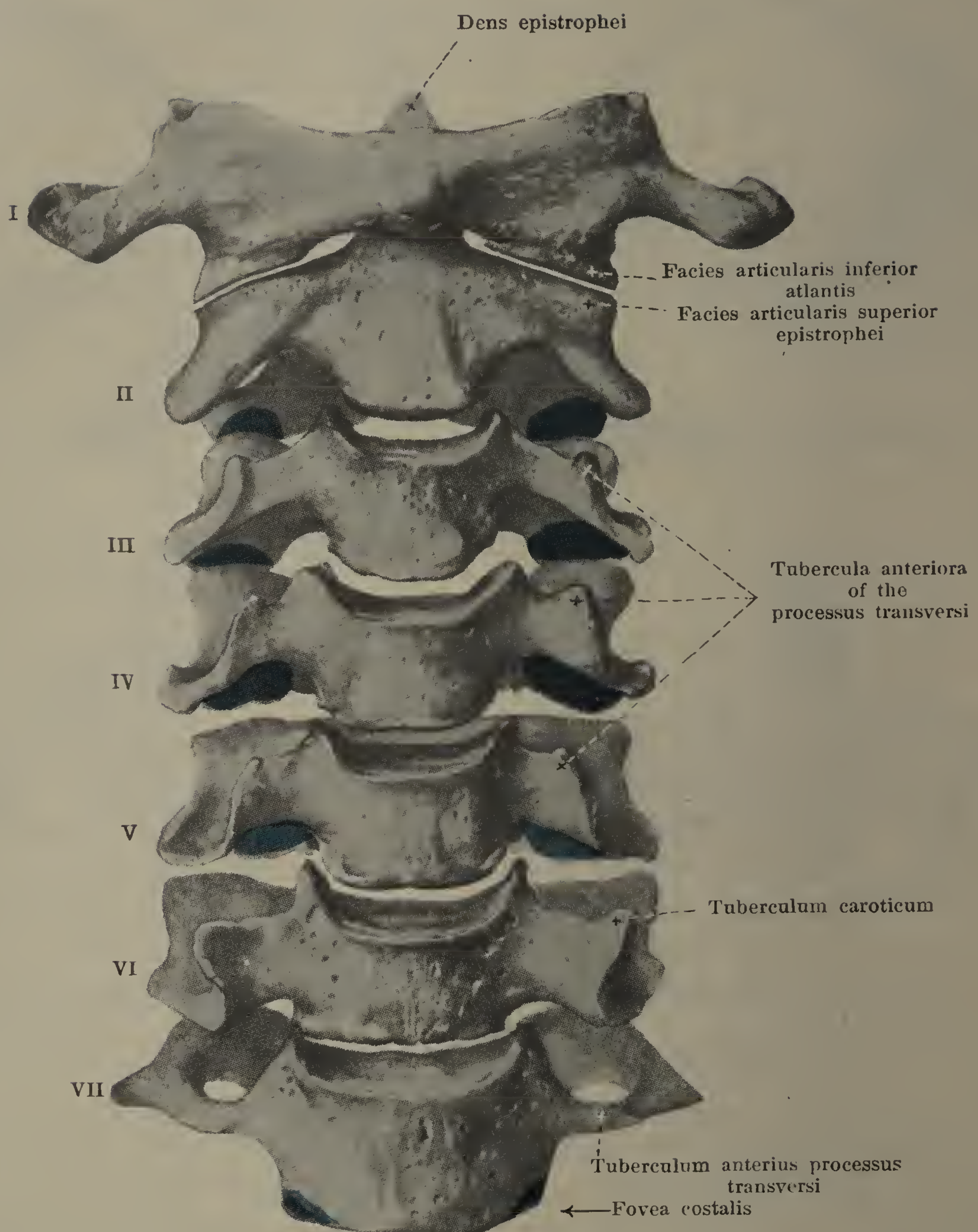
The ***first cervical vertebra,*** the **atlas** (see also Fig. 105), is especially characterized by the fact that it lacks the main mass of the body. The only representative of a body is a narrow mass of bone in front, *arcus anterior*, which presents, in the middle on its anterior surface, a small *tuberculum anterius*, on its posterior surface a flat *fovea dentis*, covered with cartilage. The arch proper, here called *arcus posterior*, is narrow, roundish and presents, behind in the middle, in place of the processus spinosus, a small *tuberculum posterius.* Between the two arches lie the *massae laterales;* each lateral mass possesses above an oval, concave articular surface, sometimes constricted in the middle, which sagittally and frontally is bent concave, *fovea articularis superior*, for articulation with the condylus occipitalis (oss. occipitalis), below a flat, rounded *facies articularis inferior* for articulation with the epistropheus. Lateral from each massa lateralis the processus transversus projects far lateralward; it is devoid of sulcus n. spinalis and of tubercles. Running out from the foramen transversarium is a groove which on the upper surface of the arcus posterior leads behind and sometimes under the massa lateralis to the foramen vertebrale, the *sulcus arteriae vertebralis* (for the a. and v. vertebralis; n. suboccipitalis) (see also p. 182). Incisurae vertebrales are absent in the form in which they occur in the other cervical vertebrae. The *foramen vertebrale* is very large, approximately quintagonal and corresponds to the foramen vertebrale of the other vertebrae only in its posterior, large part: the anterior part carries the dens epistrophei and the lig. transversum atlantis (see also Fig. 275).



104. Seventh cervical vertebra, *vertebra prominens,* from above.

The ***second cervical vertebra,*** the **epistropheus** (O. T. axis) (see Figs. 102, 103 and 105), is especially characterized by a thick cone, *dens (tooth)* (O. T. odontoid process), which ascends from the upper surface of the body; this presents, both in front and behind, a small, flat surface, covered with cartilage, *facies articularis anterior* and *posterior*, and ends above in a blunt tip. Near the odontoid process on the lateral part of the body lie the rounded, slightly convex *facies articulares superiores* directed obliquely lateralward and upward. The processus articulares inferiores and spinosus as well as the foramen vertebrale show no especial deviations; the processus transversi lack the tubercula anterius and posterius as well as the sulcus n. spinalis; the foramen transversarium is present below the facies articularis superior as a short canal., curved laterally above. The incisura vertebralis inferior is present and situated as in the other cervical vertebrae, i. e. in front of the processus articularis. An exactly corresponding incisura vertebralis superior is however absent; but behind the facies articularis superior is a groove for the n. spinalis II.

The ***seventh cervical vertebra*** (see also Fig. 105) is characterized by an especially long, powerful, non-bifurcated processus spinosus, which on palpation of the spine from above is usually the first to be distinctly felt; the vertebra is accordingly named the **vertebra prominens.** It has in addition longer processus transversi; its foramen transversarium is sometimes absent, it is nearly always small, is sometimes subdivided and often serves for the passage of the v. vertebralis (very seldom also the a. vertebralis). On the lower margin of the lateral surface of the body at one or both sides a *fovea costalis* is sometimes present for articulation with the head of the first rib. The part situated in front of the foramen transversarium (processus costarius, see p. 73), is usually more feebly developed than the posterior part, but is sometimes encountered movable, as a so-called *cervical rib*, in which case its length may vary greatly (see Fig. 117, No. 4).

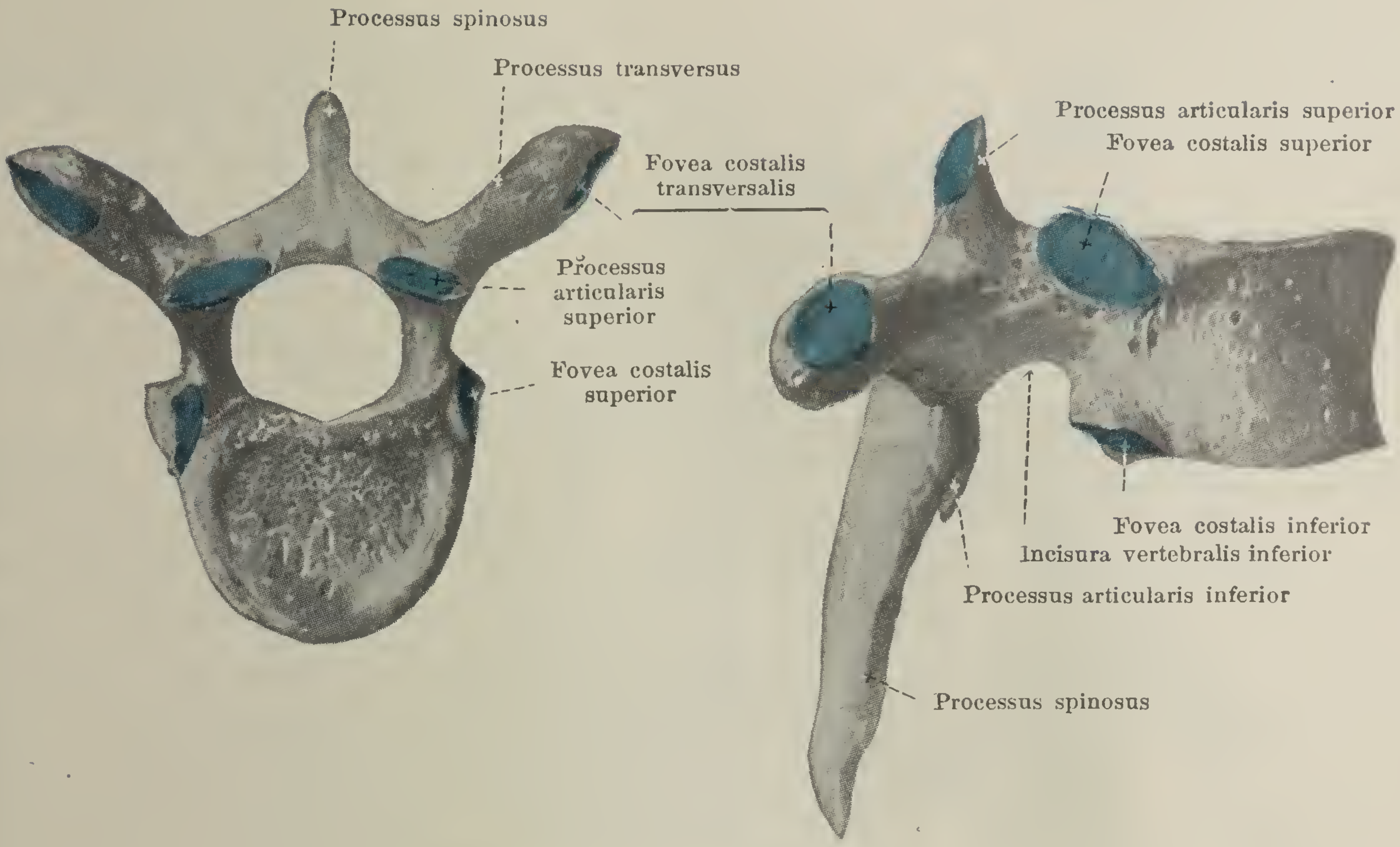

Dens epistrophei
I
Facies articularis inferior atlantis
Facies articularis superior epistrophei
II
III
Tubercula anteriora of the processus transversi
IV
V
Tuberculum caroticum
VI
VII
Tuberculum anterius processus transversi
Fovea costalis

105. Cervical spine, *vertebrae cervicales,* from in front.

The bodies of the *cervical vertebrae* grow gradually broader from the 2nd to the 7th. The adjacent surfaces of the same are so curved that the under surface of each vertebra always fits into the upper surface of the next vertebra below.

The processus transversi on the whole diminish gradually in length from the seventh upward as far as the second vertebra; then follow immediately the widely projecting processus transversi of the atlas. The tubercula anteriora of the processus transversi increase in size from the third to the sixth vertebra; those of the sixth vertebra are called the *tubercula carotica;* on the seventh vertebra they are only feebly developed (see also Fig. 104).

The processus spinosi are short from the second to the (fifth or) sixth cervical vertebra, usually bifurcated and increase gradually somewhat in length; on the (sixth and) seventh cervical vertebra they are long and not bifurcated.


Processus spinosus
Processus transversus
Fovea costalis transversalis
Processus articularis superior
Fovea costalis superior
Processus articularis superior
Fovea costalis superior
Fovea costalis inferior
Incisura vertebralis inferior
Processus articularis inferior
Processus spinosus

106 and 107.

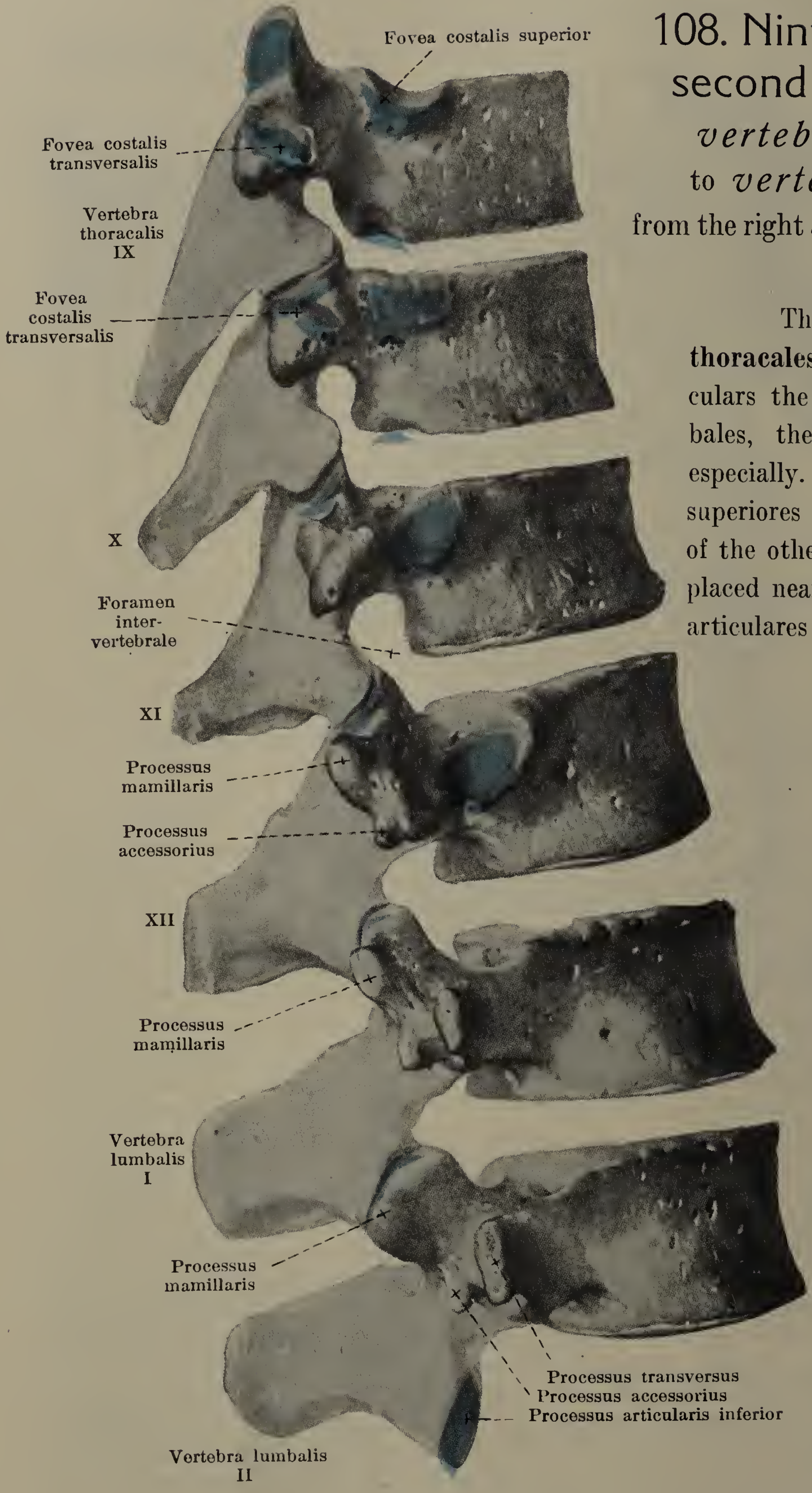
Sixth thoracic vertebra, *vertebra thoracalis VI,*

from above. from the right.

The vertebrae movably connected with ribs are called the **vertebrae thoracales** *(thoracic vertebrae)* (O. T. dorsal vertebrae), generally twelve in number (see also Figs. 96, 97, 108, 127 and 128); they possess broad *bodies* which in front are slightly lower than at the back. The connecting surfaces of the bodies are flat and on the upper and lower vertebrae are described as bean-shaped, on the middle vertebrae as more heart-shaped. The *foramen vertebrale* is narrow and rounded. The *processus articulares* stand vertical and nearly frontally, their *facies articulares* are very variable, smooth or slightly curved and form parts of the mantle of a cylinder, the axis of which is situated in front of the foramen vertebrale; the facies articulares superiores look backward, the facies articulares inferiores forward. The *processus transversi* arise between the processus articulares and are very powerful; they are, below more than above, directed obliquely backward and lateralward. On the anterior surface of their lateral extremity they present a small fossa covered with cartilage, the *fovea costalis transversalis* (O. T. facet for tubercle of rib), for articulation with the tuberculum costae; they are absent from the eleventh and twelfth (see Fig. 108), sometimes also from the tenth vertebra. The *processus spinosi* are long, triangular, apical and directed more or less markedly downward; the middle ones cover one another like tiles of a roof (see Figs. 127 and 128). The small articular surfaces which lie on the lateral surfaces of the bodies of the vertebrae, just in front of the roots of the vertebral arches, are special peculiarities of the thoracic vertebrae. On the nine upper vertebrae two of these are present on each bone, one larger at the upper margin, *fovea costalis superior* (O. T. demifacet for head of rib), and one smaller on the lower margin, *fovea costalis inferior;* each fovea costalis inferior forms with the fovea costalis superior of the next vertebra below and with the intervertebral disc lying between them the articular surface for one capitulum costae. On the tenth to the twelfth vertebra (see Figs. 97, 108) there is only one *fovea costalis;* on the tenth it lies on the upper margin, on the eleventh and twelfth vertebra in the middle of the lateral surface. (For development see p. 98.)

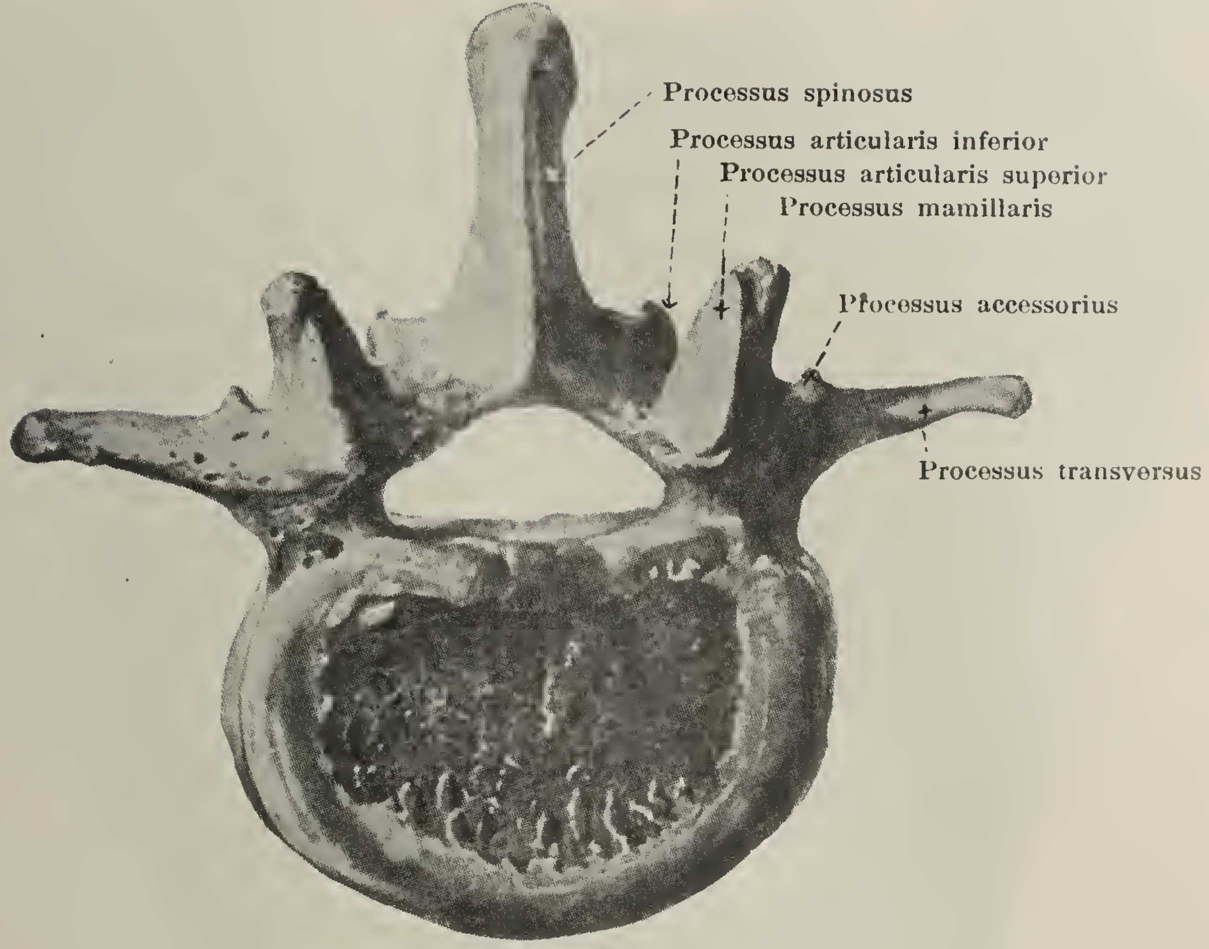
108. Ninth thoracic to the second lumbar vertebra,

vertebra thoracalis IX
to *vertebra lumbalis II,*
from the right and somewhat from behind.



The lower two **vertebrae thoracales** approach in many particulars the form of the vertebrae lumbales, the twelfth thoracic vertebra especially. The processus articulares superiores of the latter are, like those of the other thoracic vertebrae, usually placed nearly frontally; their processus articulares inferiores on the contrary, like those of the lumbar vertebrae, nearly sagittally. This change in the direction of the processus articulares may occur even at the eleventh thoracic vertebra.

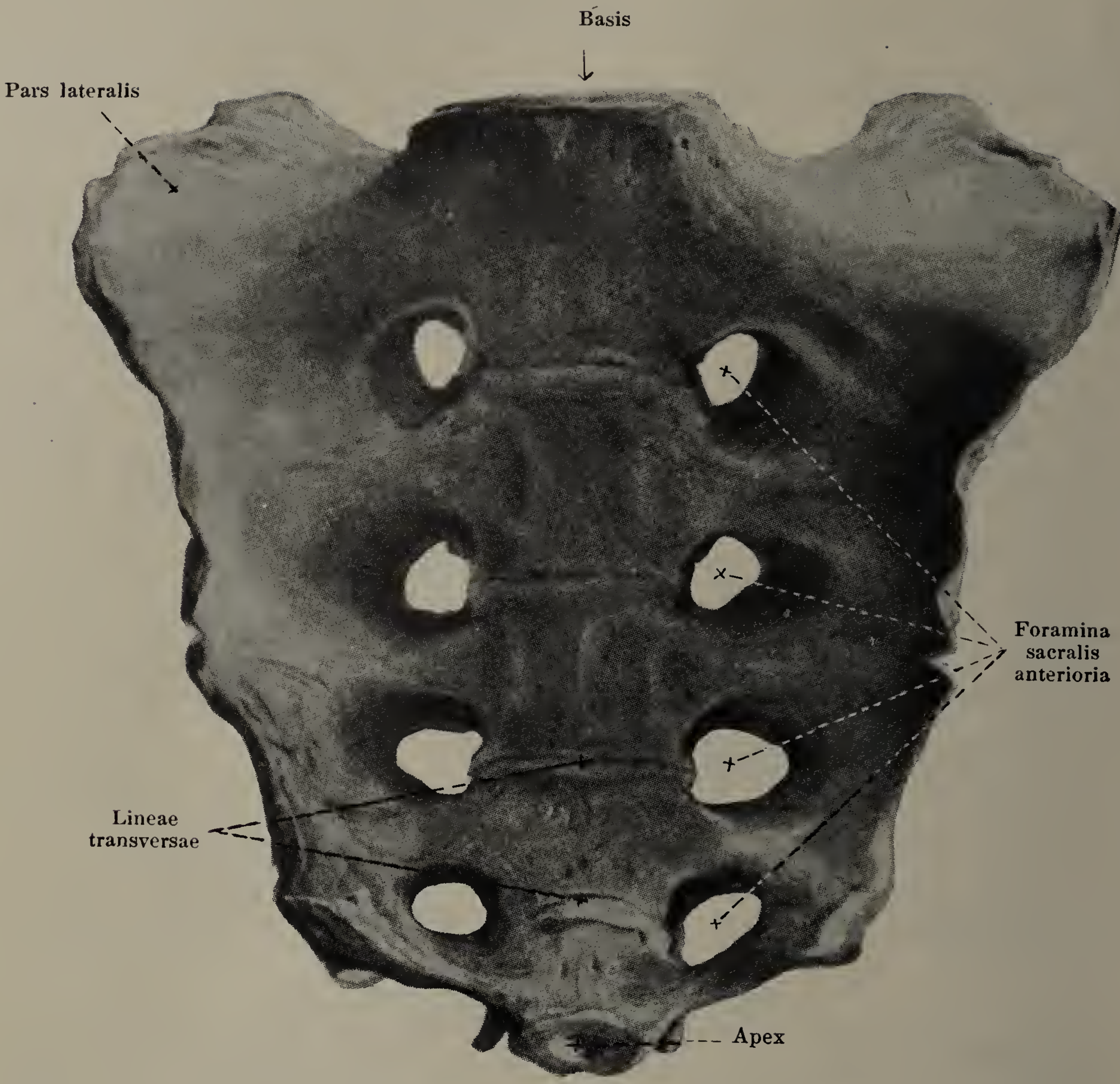
Further, on the posterior surface of the processus transversi and articulares superiores small projections are present which resemble in form and position the *processus accessorii* and *mamillares* of the lumbar vertebrae (see p. 79); these are usually distinctly marked on the twelfth thoracic vertebra, less so on the eleventh and tenth. The processus transversi are short and directed markedly backward.



109. Third lumbar vertebra, *vertebra lumbalis III,* from above.

Vertebrae lumbales *(lumbar vertebrae)* (see also Fig. 108) is the name of the vertebrae, usually five in number, underneath the thoracic vertebrae (see p. 77), between the latter and the sacrum. They are higher and broader than the cervical and thoracic vertebrae. Their *bodies* have flat connecting surfaces, varying from a bean-shaped to a transversely oval form and are on the upper four vertebrae approximately at the same height both behind and in the front. The *foramen vertebrale* is narrow and triangular. The *processus articulares* are vertical; their *facies articulares* lie nearly in sagittal planes; the *facies articulares superiores* are concave behind and hollowed out medianward, the *facies articulares inferiores* are convex in front and lateralward, so that the two belong to a cylinder-mantle, the axis of which is situated behind the processus spinosus; every two processus articulares superiores surround the processus articulares inferiores of the next vertebra above as an axle-box does an axle. On the posterior margin of the processus articularis superior a blunt bony mass, the *processus mamillaris*, projects backward. The *processus spinosi* are flat and high, pass straight backward, end in a swollen extremity and are often bent hook-like downward. The *processus transversi* arise in front of the processus articulares from the region of the radix arcus vertebrae; they are thin, flat and directed only slightly backward. They are considered from their largest part to be homologues of the ribs; the corresponding part is accordingly also designated as the *processus costarius;* this is sometimes especially large on the first lumbar vertebra and united by a joint with the rest of the process; it is then called a *lumbar rib* (see Fig. 117, No. 8). On the posterior surface of the root of the transverse process, lateral from and below the processus mamillaris, a small, variably developed nodule, the *processus accessorius*, projects backward. (For development see p. 98.)

The fifth lumbar vertebra (see Fig. 117, No. 9) is peculiar in that its body excels all the others in size; furthermore its body is essentially higher in front than behind (see Figs. 203 and 204); its processus transversi are short, thick and bluntly wedge-shaped, springing with a broad base from the posterior segment of the body and from the root of the arch and directed lateralward and a little backward and upward; the processus articulares superiores are directed more backwards, the processus aticulares inferiores more forwards, than those of the other lumbar vertebrae.

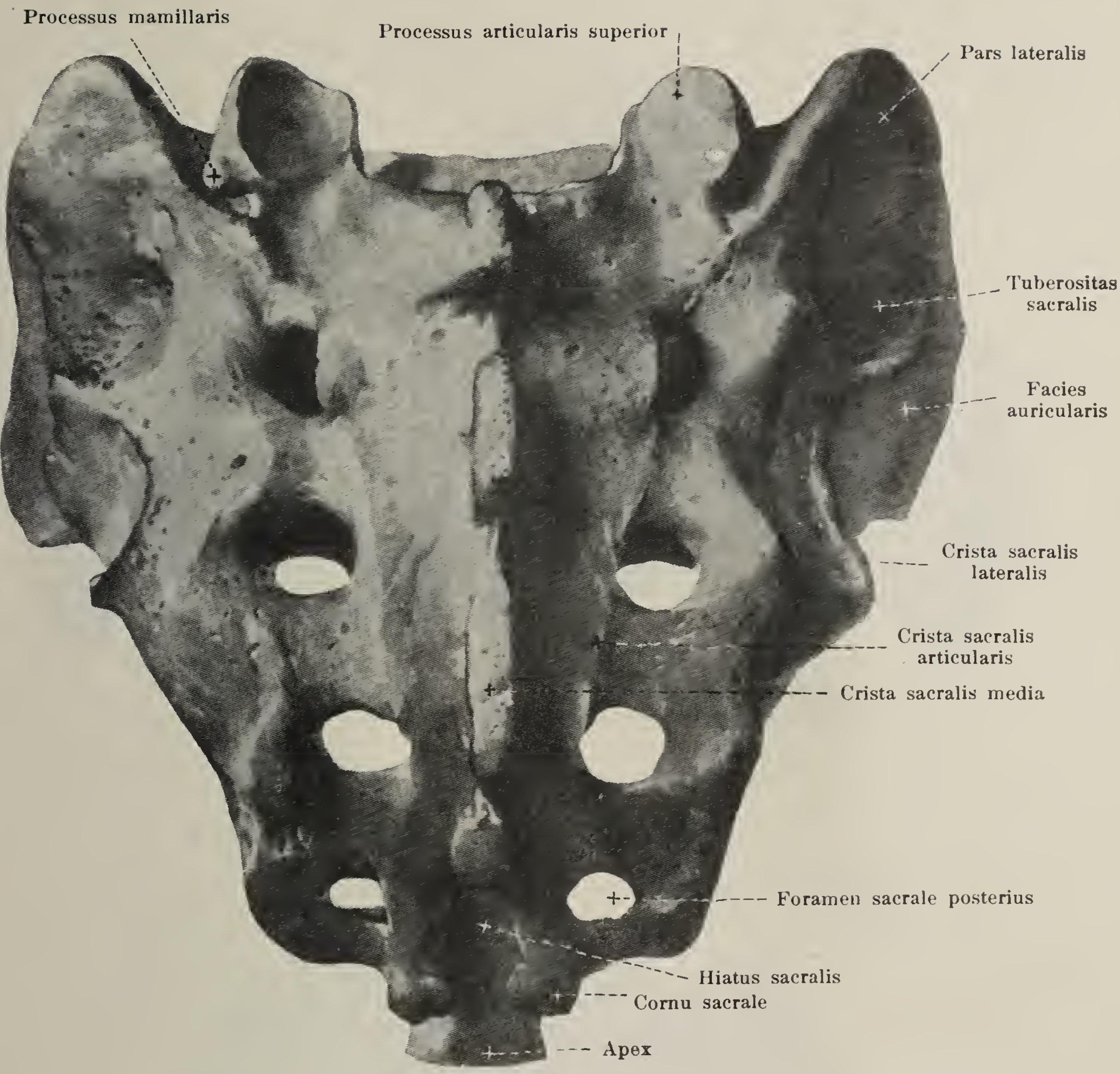


110. **Sacrum,** ***os sacrum,*** from in front and below.

Vertebrae sacrales is the name of the five (sometimes six, seldom four) vertebrae, which are distinctly separated from one another in youth only; in the adult (towards the 25th year) they are fused to a single bone, the **os sacrum** (see also Figs. 111—114), which is situated in the lowest part of the spine and is the largest and broadest bone of it. (For development see p. 98.)

The os sacrum is wedge-shaped, broad above *(basis)*, pointed below *(apex)* and often a little more bent about the middle of the third vertebra; it is broadest in the region of the first sacral vertebra, narrows itself somewhat at the second, again usually broadens somewhat at the third vertebra, and from there on constantly diminishes in width; near the tip it possesses an incisura, one on each side; its sagittal diameter also diminishes essentially from above downward. Its anterior inferior surface, *facies pelvina,* looking into the pelvis, is concave, its posterior upper surface, *facies dorsalis,* is convex.

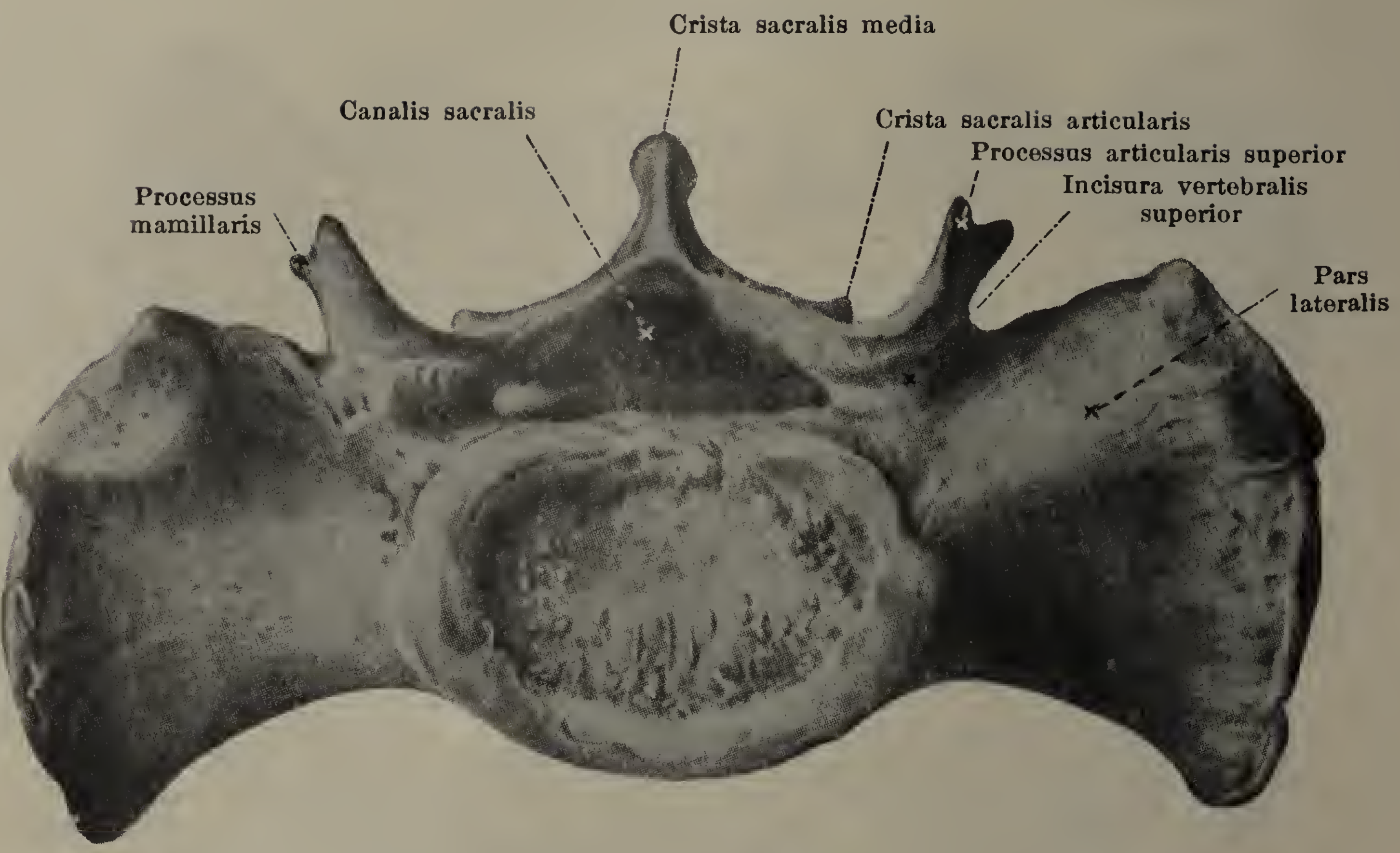
The anterior inferior surface, **facies pelvina,** is in general smooth and concave. In the middle, four *lineae transversae* are to be seen, lines corresponding to the places where the five individual bodies of the sacral vertebrae have grown together. Lateral from them on each side lying in a vertical series over one another are the four *foramina sacralia anteriora,* which behind and medianward lead into the *canalis sacralis* (see Fig. 113), but, lateralward, run out into grooves on the anterior surface of the partes laterales. The foramina sacralia anteriora diminish in size from above downward; below the last one, near the apex ossis sacri, is a notch which is closed by the processus transversus ossi coccygis and by the ligamentum sacrococcygeum laterale to form a fifth foramen sacrale. The *apex ossis sacri* presents a small oval, flat surface which is formed by the body of the fifth sacral vertebra only and is united at the *symphysis sacrococcygea* with the upper surface of the coccyx.



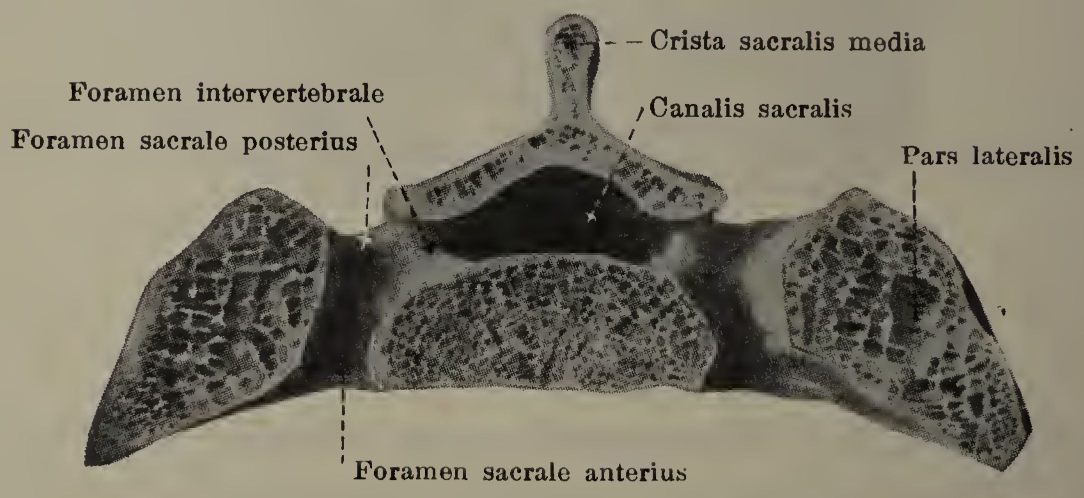
111. Sacrum, *os sacrum,* from behind and above.

The **facies dorsalis ossis sacri** is very rough and convex from above downward and from right to left. On it five rows of processes and projections run downward, almost parallel to one another. The middle row, *crista sacralis media,* has resulted from the fusion of the processus spinosi and is most marked; it presents often an uninterrupted ridge and four tuberosities corresponding to the processus spinosi of the four vertebrae, but is frequently incomplete. Lateralward on each side lies the *crista sacralis articularis;* it is to be considered as the processus articulares fused with one another and usually projects only moderately above the surface and can sometimes be recognized as oblong ledged projections one on the medial side of the foramina sacralia. Lateralward from this, separated from it by the foramina sacralia posteriora, is the *crista sacralis lateralis;* it arises from the fusion of the processus transversi, consists of a row of tuberosities and is usually more distinctly marked than the crista sacralis articularis. The four *foramina sacralia posteriora* converge a trifle downwards; they are smaller and more rounded than the anterior ones, and lead (see Fig. 113) forward and medianward into the canalis sacralis, forward and downward to the foramina sacralia anteriora.

Corresponding to the upper end of the cristae sacrales articulares the two completely developed *processus articulares superiores* of the first sacral vertebra pass vertically upward, on which, as on the lumbar vertebrae, a *processus mamillaris* is frequently developed on both sides; their facies articulares superiores are directed backward and somewhat medianward and articulate whith the processus articulares inferiores of the fifth lumbar vertebra. From the lower end of the cristae sacrales articulares the two small *cornua sacralia* pass downward to meet the cornua coccygea ossis coccygis. Medianward from them lies the lower opening of the canalis sacralis, *hiatus sacralis;* it is usually triangular and varies much in size and arises from the incomplete closure of the arch of the fifth lumbar vertebra and the abscence of its processus spinosus.


Crista sacralis media
Canalis sacralis
Crista sacralis articularis
Processus articularis superior
Processus mamillaris
Incisura vertebralis superior
Pars lateralis

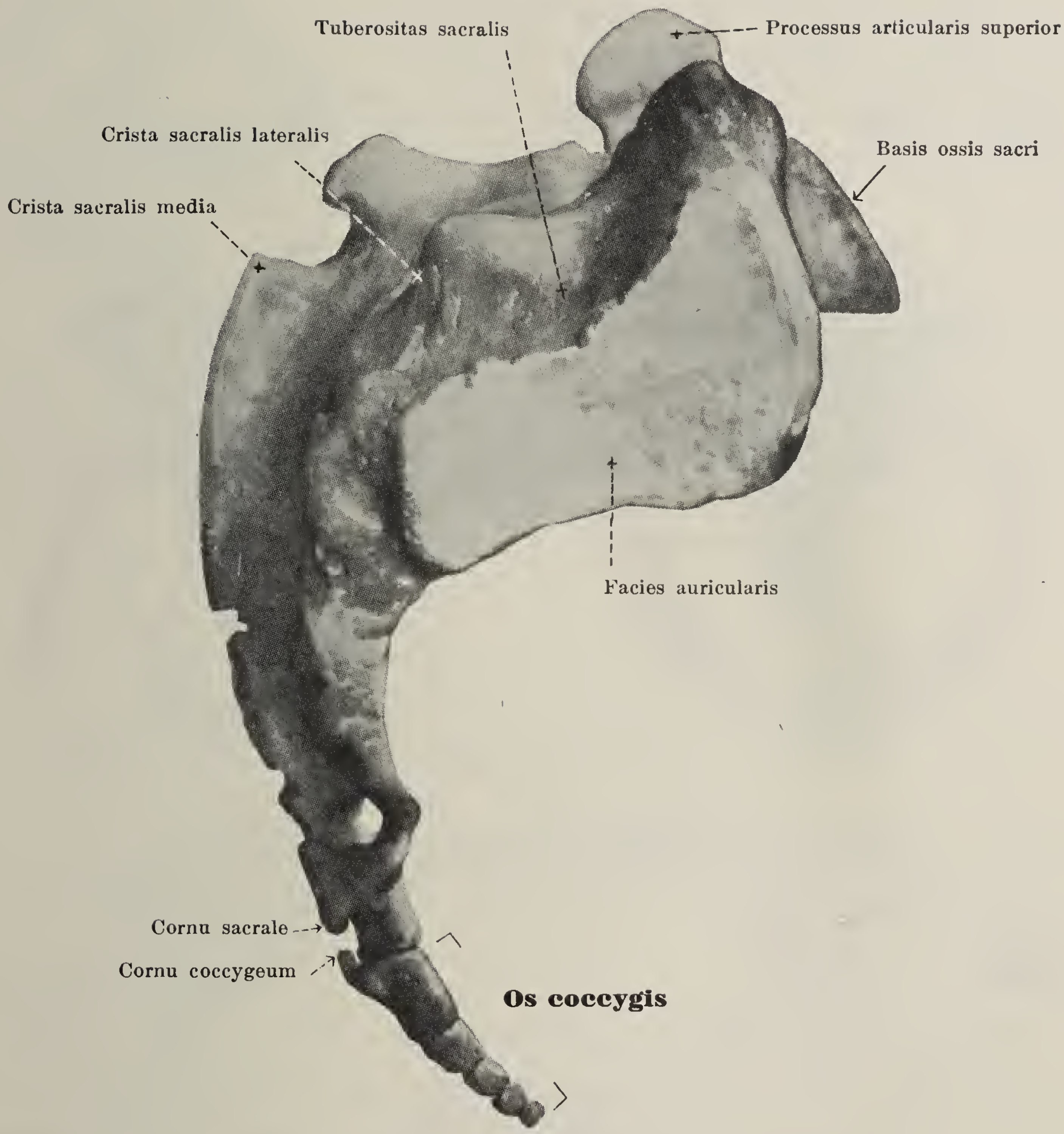
112. Sacrum, *os sacrum,* from above.



113. Transverse section through the sacrum at the level of the second pair of foramina sacralia.

The anterior upper surface of the sacrum, **basis ossis sacri** (see also Figs. 110, 111 and 114), contains in the middle a somewhat projecting, transversely oval, flat surface slightly depressed and rough in the middle (the juncture of the 1st sacral vertebra), with which the body of the fifth lumbar vertebra is connected by means of an intervertebral disc. Behind this lies the upper triangular opening of the *canalis sacralis* which passes through the sacrum as a flattened, triangular canal from above downward and reaches its lower extremity in the hiatus sacralis on the posterior surface, a little above the apex (see Figs. 202 and 203); within the bone at the junctions of the vertebrae sacrales going off from it on each side are four short canals *(foramina intervertebralia)* which are continued ⊣-shaped into the foramina sacralia anteriora and posteriora. Lateralward from the upper opening of the canalis sacralis the *processus articulares superiores* of the 1st sacral vertebra (see p. 81) project upward; in front of them lie the *incisurae vertebrales superiores.* The lateral portions of the basis ossis sacri are smooth, somewhat concave and form the anterior, upper limiting surfaces of the partes laterales ossis sacri.

Through the union of the fifth lumbar vertebra with the sacrum there arises, at the site of junction in front, an angle projecting somewhat downward and forward, the *promontorium* (O. T. sacrovertebral angle) (see Figs. 202 and 203).

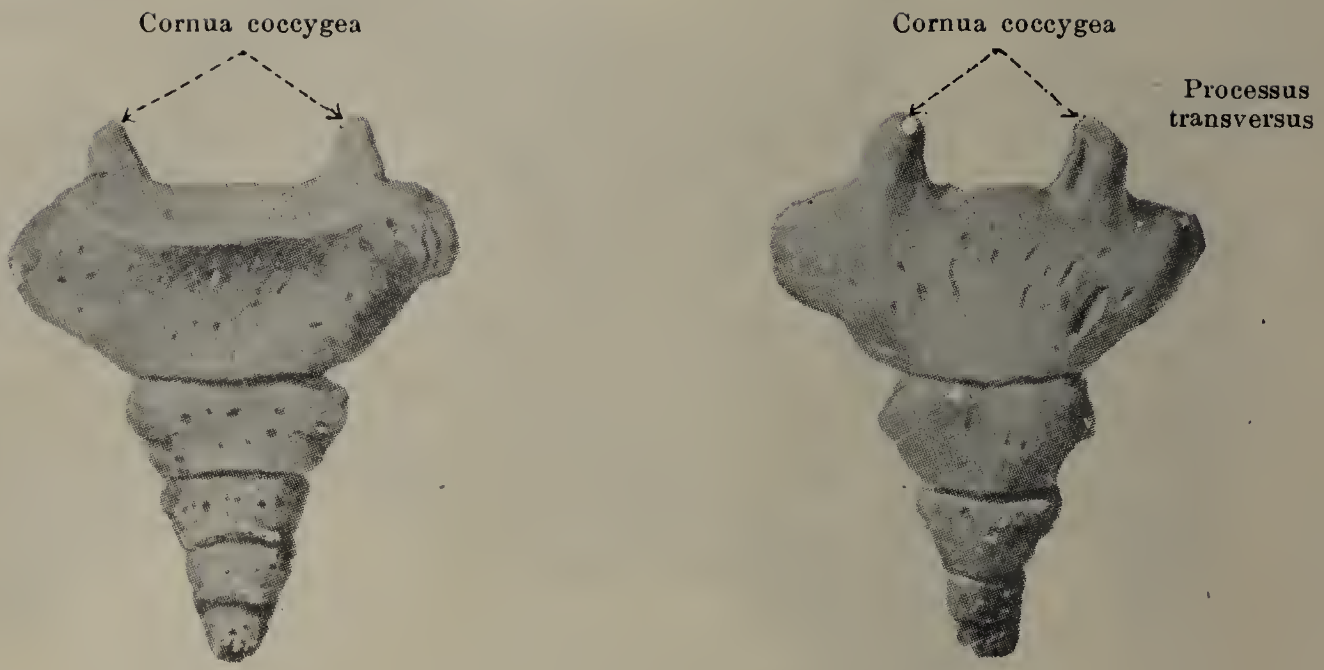


114. Sacrum and coccyx, *os sacrum* and *os coccygis* from the right.

The portions which lie lateralward from the foramina sacralia are called the **partes laterales ossis sacri** (see also Figs. 110—113); they have arisen through fusion of the transverse processus and of rudiments of ribs (on the upper three vertebrae). The partes laterales grow much narrower from above downward and present on the upper part of their free lateral surfaces an uneven roughly triangular joint surface, *facies auricularis*, covered with cartilage, for union with the hip bone; it is formed in the main by the first sacral vertebra, less by the second and least by the third. Behind the facies auricularis lies a markedly roughened surface, *tuberositas sacralis*, to which are attached the ligamenta sacroiliaca interossea; medially and dorsally from it runs the crist sacralis lateralis along the facies dorsalis downwards. The pars lateralis along its anterior and inferior surface helps to form the facies pelvina.

Sometimes the uppermost vertebra of the sacrum is fused laterally with the pars lateralis only in one-half, while on the other half it has a shape similar to that of the 5th lumbar vertebra; such a transition form is called a *lumbosacral vertebra* (see Fig. 117, No. 11).

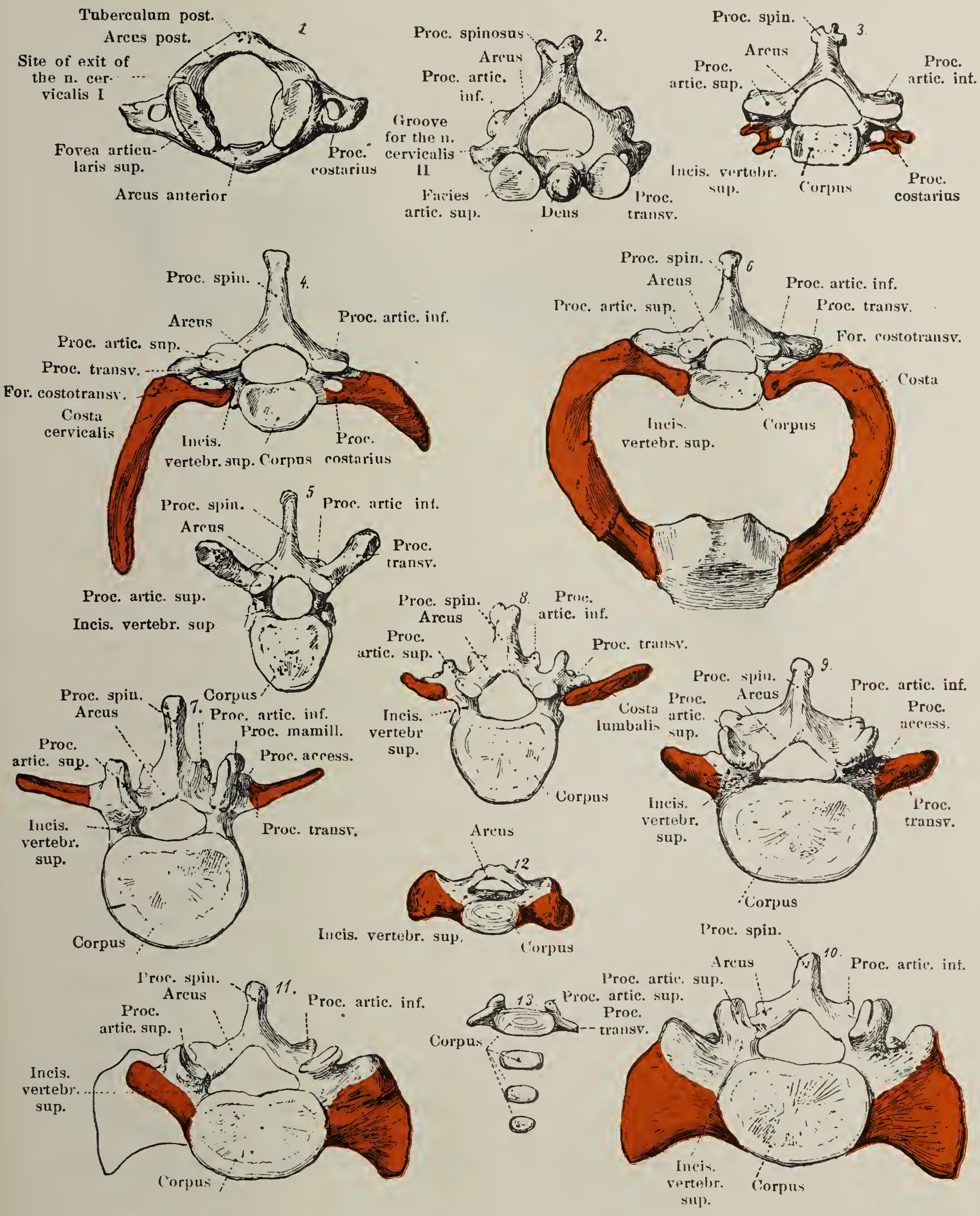
The sacrum usually presents certain differences in the two sexes. In man, it is longer, relatively narrower and also more markedly curved; in woman it is shorter, relatively broader and the curve is flatter (see Figs. 196—203).



115 and 116. Coccyx, *os coccygis,*
from in front. from behind.

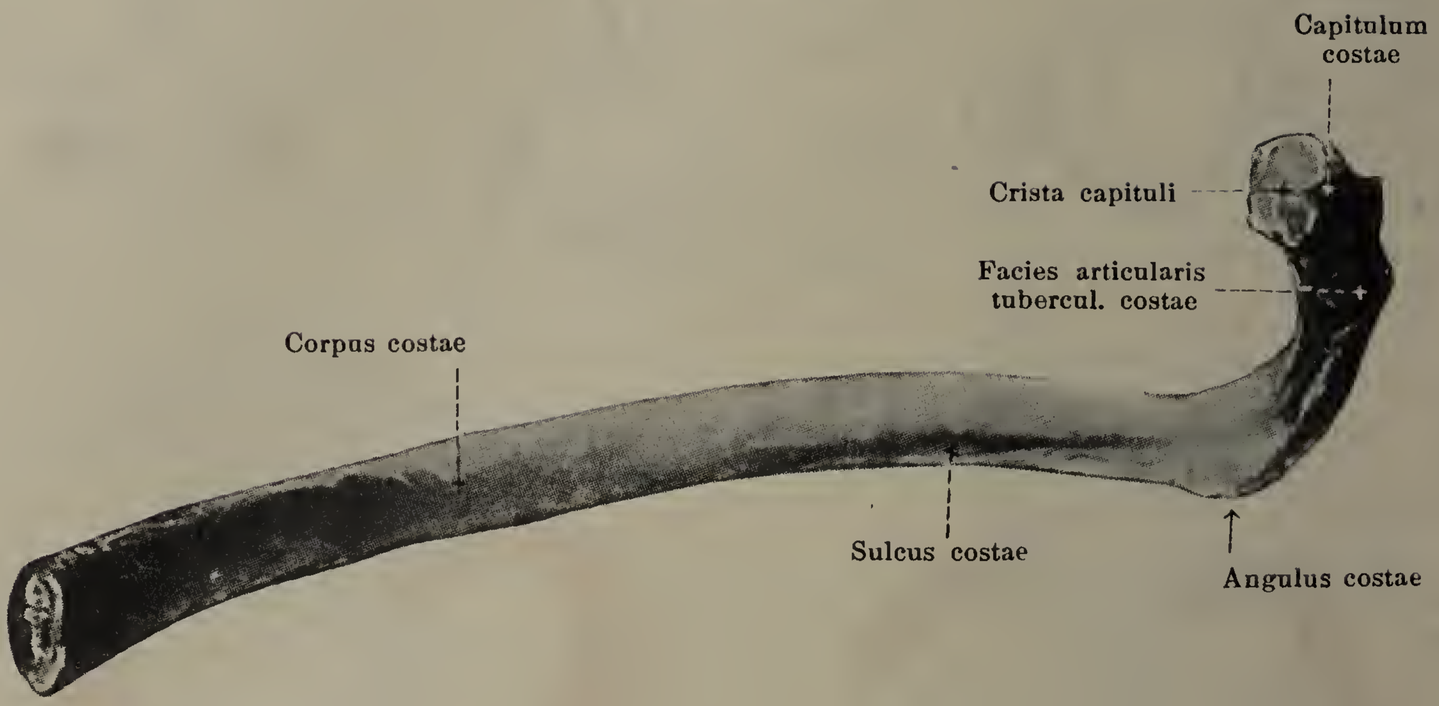
The **os coccygis** (see also Fig. 114) lies as a small, triangular bone at the lower end of the vertebral column below the sacrum. It consists of from four to five rudimentary *vertebrae coccygeae,* of each of which the body only, as a rule, is present. The first possesses still two small, transversely directed *processus transversi* and in place of the processus articulares superiores two flat processes, *cornua coccygea,* directed upward. The succeeding vertebrae diminish in size from above downward and represent actually only small oblong or spherical pieces of bone. (For development see p. 99.)

The upper surface of the coccyx is united with the tip of the sacrum by the *symphysis sacrococcygea* (see p. 180). The first and second as well as the second and third coccygeal vertebra are usually united with one another by a layer of fibro-cartilage, the third and fourth as well as the fourth and fifth by bony substance. Deviations occur very often in that the connections between the first three or that between the coccyx and sacrum ossify.



117. *Collection of different* vertebrae *and* vertebral varieties *to illustrate the morphological value of the single parts* (after Quain).

1. Atlas; 2. epistropheus; 3. fifth cervical vertebra; 4. seventh cervical vertebra with cervical rib; 5. mid-thoracic vertebra; 6. first thoracic vertebra with ribs and a part of the sternum; 7. third lumbar vertebra; 8. first lumbar vertebra with lumbar rib; 9. fifth lumbar vertebra; 10. first sacral vertebra; 11. lumbosacral vertebra; 12. fourth sacral vertebra of a young individual; 13. four coccygeal vertebrae.
All the vertebrae are drawn as seen from above.



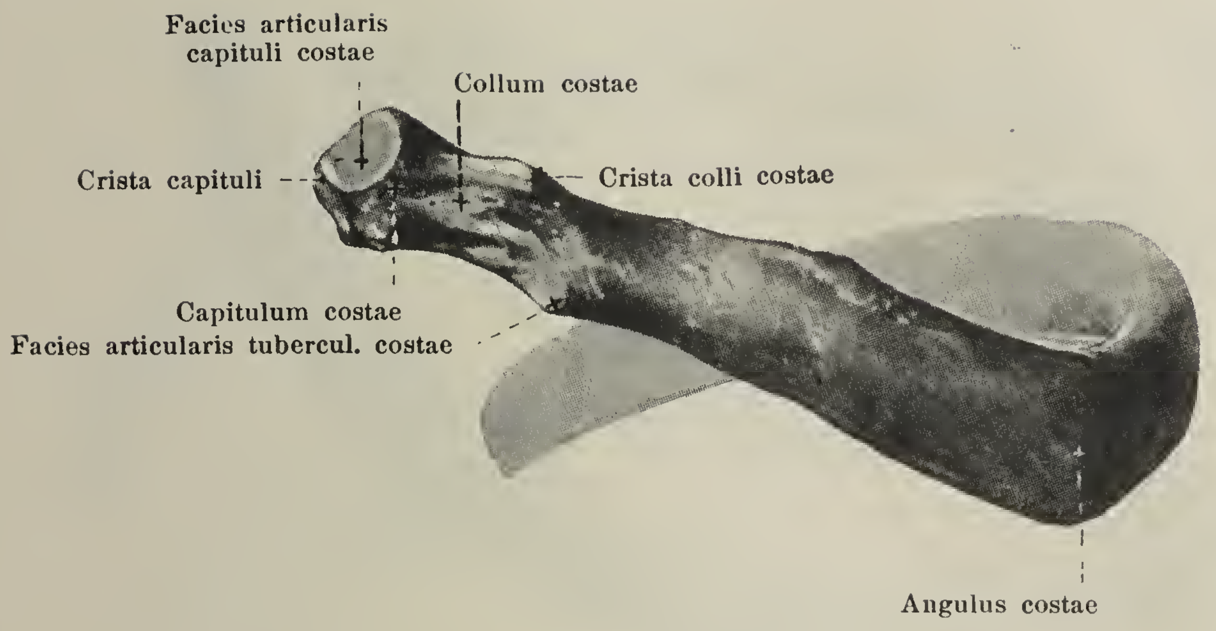
118. **Seventh rib of right side,** *costa VII,* from within.

The *twelve* **costae** *(ribs)* (see also Figs. 119—123, 126—128) are thin, partly bony, partly cartilaginous masses which go out on each side from the lateral surfaces of the thoracic vertebrae and which, forming an arch which is convex lateralward, help to bound the thoracic cavity. To each thoracic vertebra corresponds a pair of ribs; they are numbered from above downward. Their length increases from the first to the seventh; and decreases again from the eighth down. (For the development see p. 99.)

The upper seven (sometimes eight) pairs of ribs are fastened directly to the sternum in front near the median plane and are distinguished as *costae verae (true ribs)* from the lower five (sometimes four) pairs of ribs, the *costae spuriae (false ribs),* which are indirectly connected with the sternum or else end free. The eleventh and twelfth ribs which are not joined either to the other ribs or with each other, and which float freely in the abdominal muscles are named *costae fluctuantes.*

Each rib consists of a longer posterior bony portion, *os costale,* and a shorter, anterior, cartilaginous portion, the *cartilago costalis.*

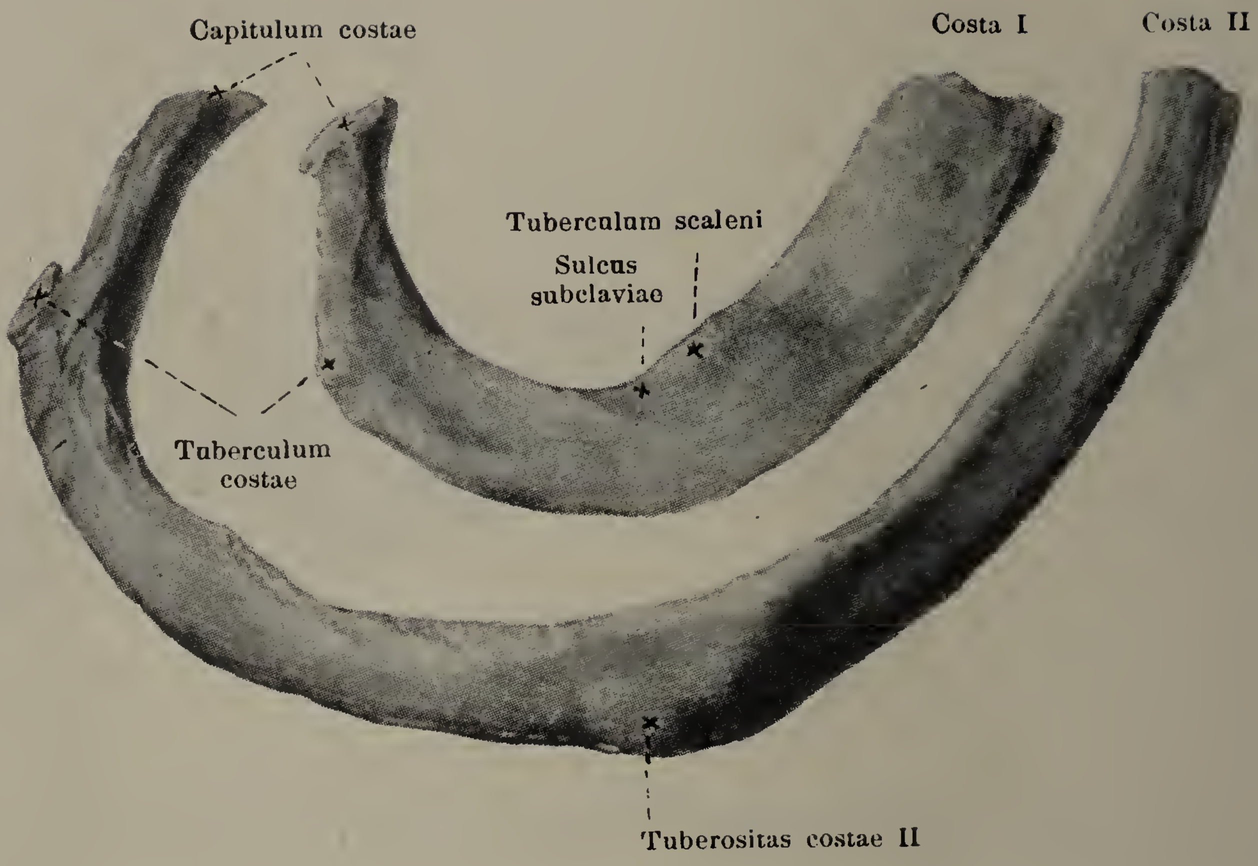
Each ***os costale*** is somewhat expanded at its vertebral end so as to form the *capitulum costae (head of the rib);* this possesses a small *facies articularis capituli costae,* covered over with cartilage, which is divided, on the ribs from the second to the tenth, by a transverse ridge, *crista capituli,* into an upper smaller and a lower larger surface. By means of these joint-surfaces the heads of the ribs articulate with the foveae costales of the bodies of the vertebrae. The portion of the bone adjoining the capitulum is somewhat narrowed, *collum costae (neck of the rib),* on the upper ribs more distinctly than on the lower; the neck presents on its upper margin a longitudinal ridge, *crista colli costae,* which is continued lateralward upon the shaft and is absent only from the first and the last ribs; at its lateral extremity a small nodule, *tuberculum costae,* projects backward and downward; this possesses a small *facies articularis tuberculi costae,* covered with cartilage, for articulation with the fovea costalis transversalis of the corresponding vertebra; it is largest on the first ribs and is absent, along with the joint surfaces, on the (tenth) eleventh and twelfth ribs.



119. Eighth rib of right side, *costa VIII,* from behind.

The middle piece or shaft of the rib, *corpus costae*, shows lateralward from the tuberculum costae a roll which is directed backward and downward, the *angulus costae;* this gives the external surface at this place the appearance of being sharply bent. This lies on the first rib close to the tubercle; on succeeding ribs it is situated ever more lateralward; it is most marked on the middle ribs and is absent from the last two ribs. The body of the rib is a flat plate of bone oblong oval in cross-section with an internal and an external smooth surface; the external surface is directed vertically in the middle ribs, markedly upward in the uppermost ribs, more downward in the lowermost (see Figs. 126—128). The curvature of a whole rib is double, since in the first place the surface of the shaft is bent so as to be convex lateralward and in the second place, its upper edge is curved so as to at the upper ribs concave, from the 7th to the 10th rib in a somewhat alternating manner ∽-shaped. On the internal surface near the lower margin runs the *sulcus costae* (for the v., a. and n. intercostalis); it begins at the tubercle, is most marked behind and becomes lost in front; on the first and last ribs it is absent or only slightly indicated. The anterior extremity is a little broadened and ends in a rough depressed surface for the reception of the costal cartilage.

The ***cartilago costalis*** *(costal cartilage)* (see also Fig. 126) has in general the same shape as the rib. It unites in front with the sternum (1st—7th) or is attached to the cartilage of the next rib above (8th—10th), or ends freely (11th and 12th ribs) (see p. 86). The cartilages increase in length from the first to the seventh; from this on they decrease so that the cartilage of the eleventh and twelfth ribs are only short pointed pieces. The first or the first two costal cartilages only follow the same direction as the bony parts of their ribs, the others are curved upward at their anterior extremities, the upper ones less than the lower. The costal cartilages often become ossified in old age, the first most frequently; the process of ossification, howewer, is not equal and differs thereby from the usual; the newly formed bone usually encases the cartilage as a sheath.

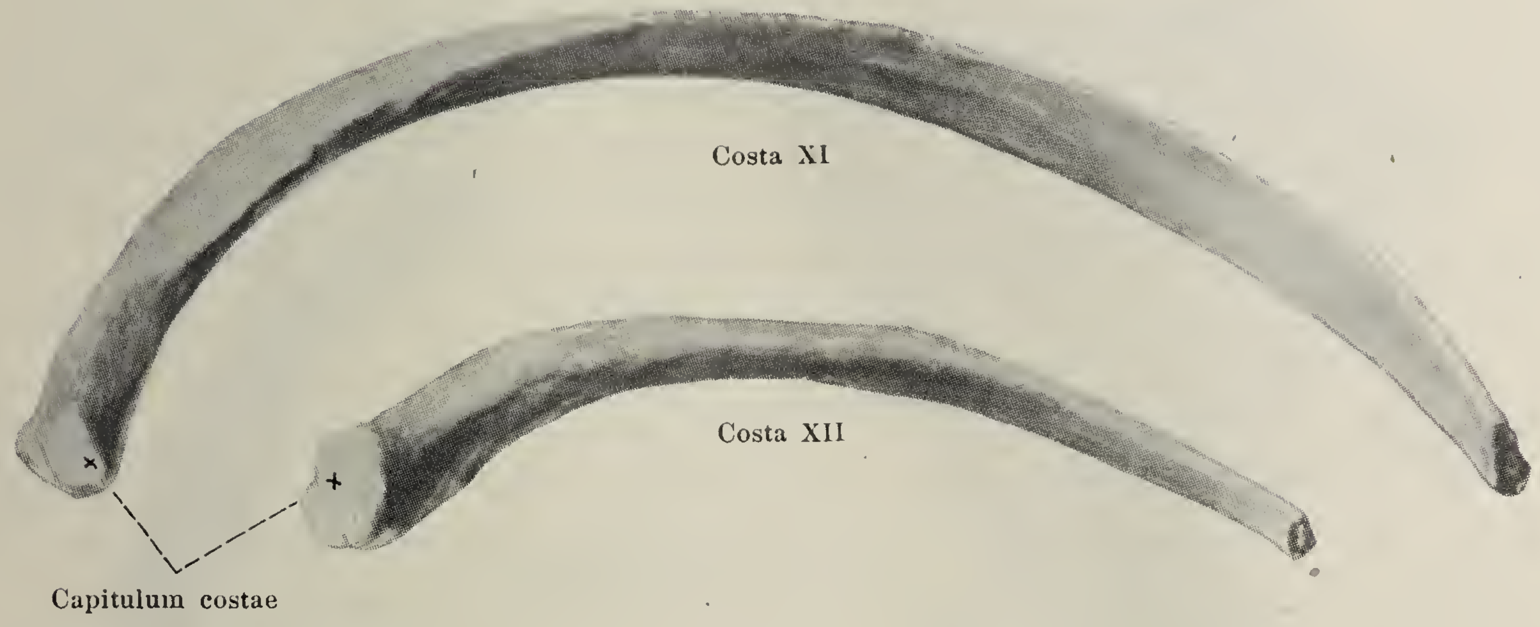


120 and 121. First and second ribs of right side, *costae I et II,* from above and without.

The first two ribs present certain peculiarities.

The **costa I** (see also Figs. 126, 128 and 129) is on the whole directed equally obliquely forward and downward and possesses an upper surface directed somewhat lateralward and a lower directed somewhat medianward. It is broad and flat particularly in front, and its anterior portion is but slightly curved. Its capitulum is usually movably connected only with the 1st thoracic vertebra. The collum costae and tuberculum costae are moderately developed, the angulus costae is missing. On the upper surface, a little in front of middle, near the medial border is a small nodule (sometimes only a roughening), *tuberculum scaleni* [*Lisfranci*] (for the attachment of the m. scalenus anterior); a very shallow furrow in front of this serves for the v. subclavia, a curve behind this, the *sulcus subclaviae,* for the a. subclavia is usually somewhat more distinctly marked. Behind the latter lies another roughened area for the m. scalenus medius.

The **costa II** (see also Figs. 126 and 128) is slender and almost twice as long as the first and resembles the other ribs in its form much more than it does the first rib. On its lateral surface, somewhat in front of the middle, is a roughened area, the *tuberositas costae II* (for the attachment of two prongs of the m. serratus anterior). Capitulum, collum and tuberculum costae are well developed. The angulus costae is missing or rather indistinct.



122 and 123. Eleventh and twelfth ribs of right side, *costae XI et XII*, from below.

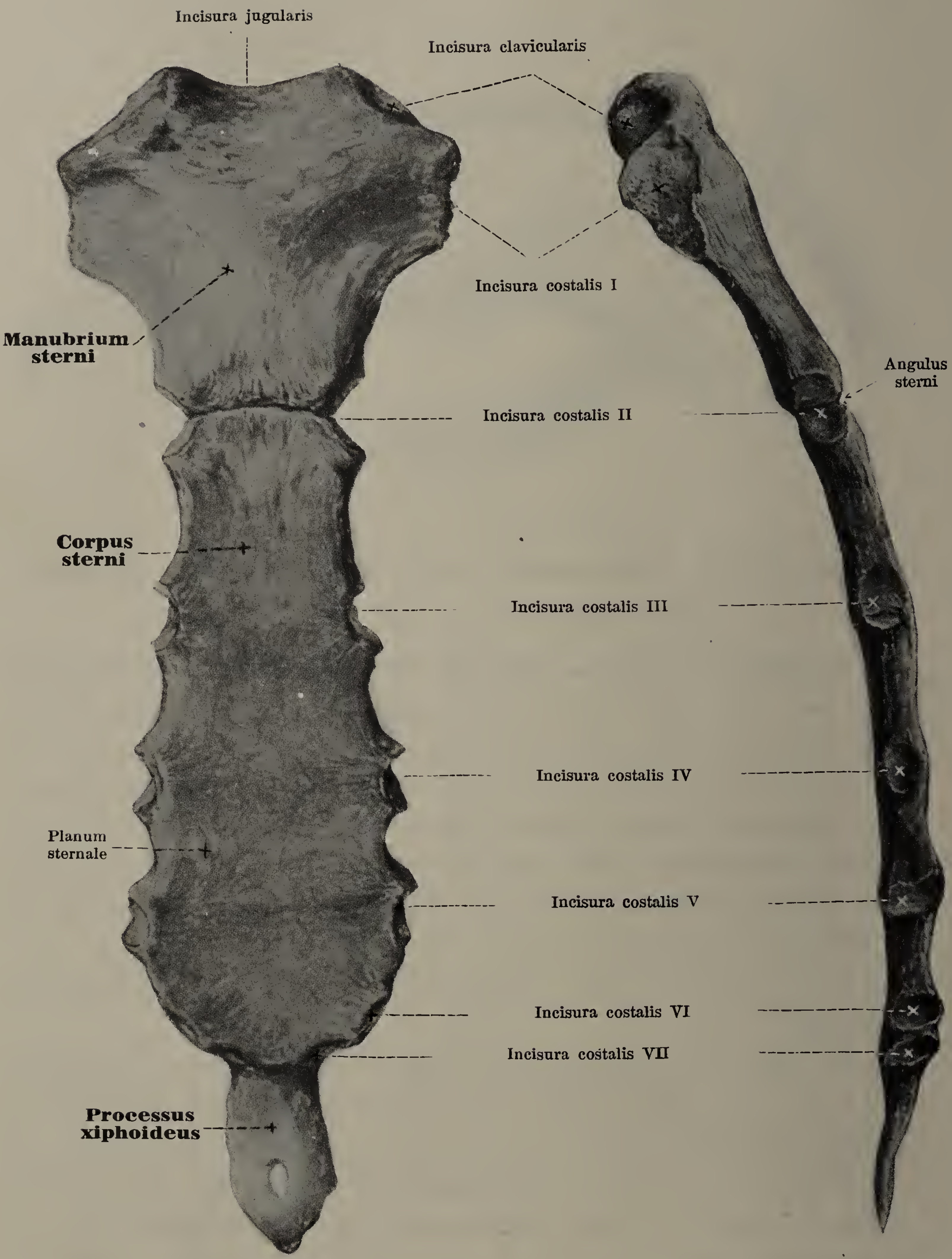
The **costa XI** is like the **costa XII** (see also Figs. 127 and 128) a delicate bone in which there can be sharply made out only a small *capitulum* behind without crista capituli; the collum costae and tuberculum costae are practically absent as are also the angulus costae and the sulcus costae. The two ribs are, in their whole length, directed almost evenly obliquely downward and curved so as to be almost evenly convex lateralward and backward. The cross-section shows rounded angles; in front the ribs become sharper and possess generally only a small cartilaginous tip. They form no joint union with the other ribs, but end free between the abdominal muscles.

The eleventh rib is fairly uniformly turned obliquely downwards through its entire length.

The twelfth rib is very variable in its length; when it is long, it runs parallel to the eleventh rib; when it is short, it runs more transversally and resembles the proc. transversus of a lumbar vertebra.

Between every two adjacent ribs is an intercostal space, **spatium intercostale** (see Figs. 126—128). Its form resembles that of the adjacent ribs and varies with their shape and position.

The disposition of the ribs along the spine forms right and left on the anterior surface of the dorsal rib sections a broad groove, ***sulcus pulmonalis*** (see Figs. 682 and 683, not designated), in which lies the lung.



124 and 125. Breast bone, *sternum,*

from in front. from the right.

The **sternum** *(breast bone)* (see also Figs. 126 and 128) lies as an unpaired oblong plate of bone in the median plane and helps to form the anterior wall of the thorax. It extends in general somewhat obliquely from behind and above, forward and downward and corresponds in position to the spine from the second or third to the ninth thoracic vertebra. Three parts are distinguishable: *manubrium sterni*, *corpus sterni* and *processus xiphoideus*, the parts being separated from one another by layers of cartilage which, however, in advanced age may ossify and lead to fusion. (For the development see p. 99.)

The ***manubrium*** **sterni** is the broadest part, especially above; below it becomes somewhat narrower; its anterior surface is slightly convex, its posterior flat. At the upper margin in the middle is a flat notch, *incisura jugularis* (O. T. presternal notch); near this at the upper angle on each side, is a somewhat deeper depression covered with fibrocartilage, the *incisura clavicularis*, for articulation with the facies articularis sternalis claviculae; right below it at its widest place is an oblong mostly rough surface, the first incisura costalis (see below).

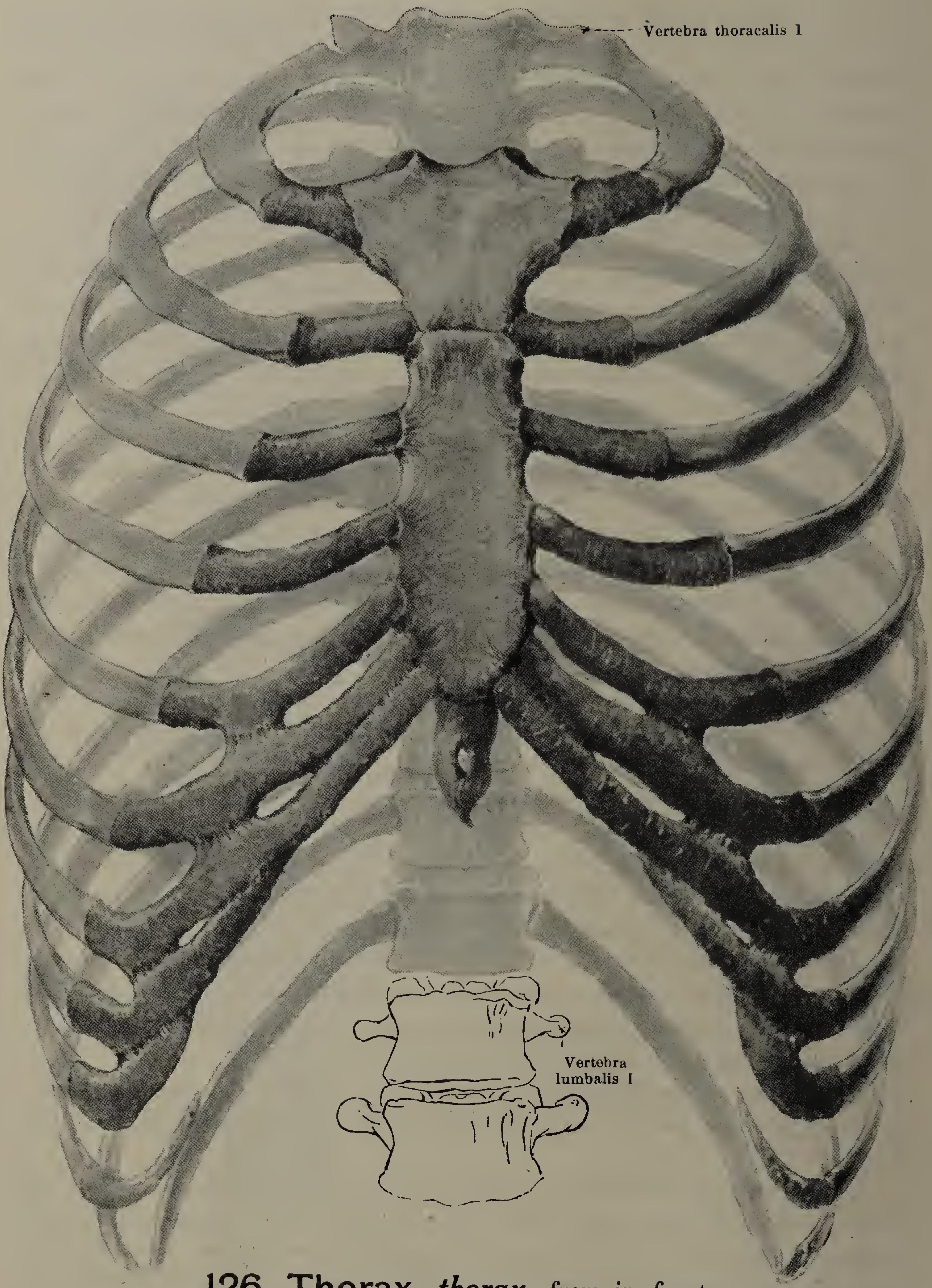
The ***corpus*** **sterni** (O. T. gladiolus) is the longest portion; it is broadest at the juncture of the 5th rib, gradually narrows slowly upwards and sharply downwards; its anterior surface, the *planum sternale,* and its posterior surface are flat. The manubrium and corpus are somewhat movable upon one another where they are united at the cartilaginous *synchondrosis sternalis* (see Figs. 276). At this place the two sections always meet under an angle, *angulus sterni;* the size of the angle is individual and differs according to sex (the angle in the female is generally smaller than in the male) and fluctuates during respiration as long as the joint is not ossified (vide supra).

The ***processus xiphoideus*** (O. T. ensiform process) forms the lower extremity; it is thin, longer than it is broad, very irregular in shape, often bifurcated or perforated by an opening. Late in life it usually fuses with the body.

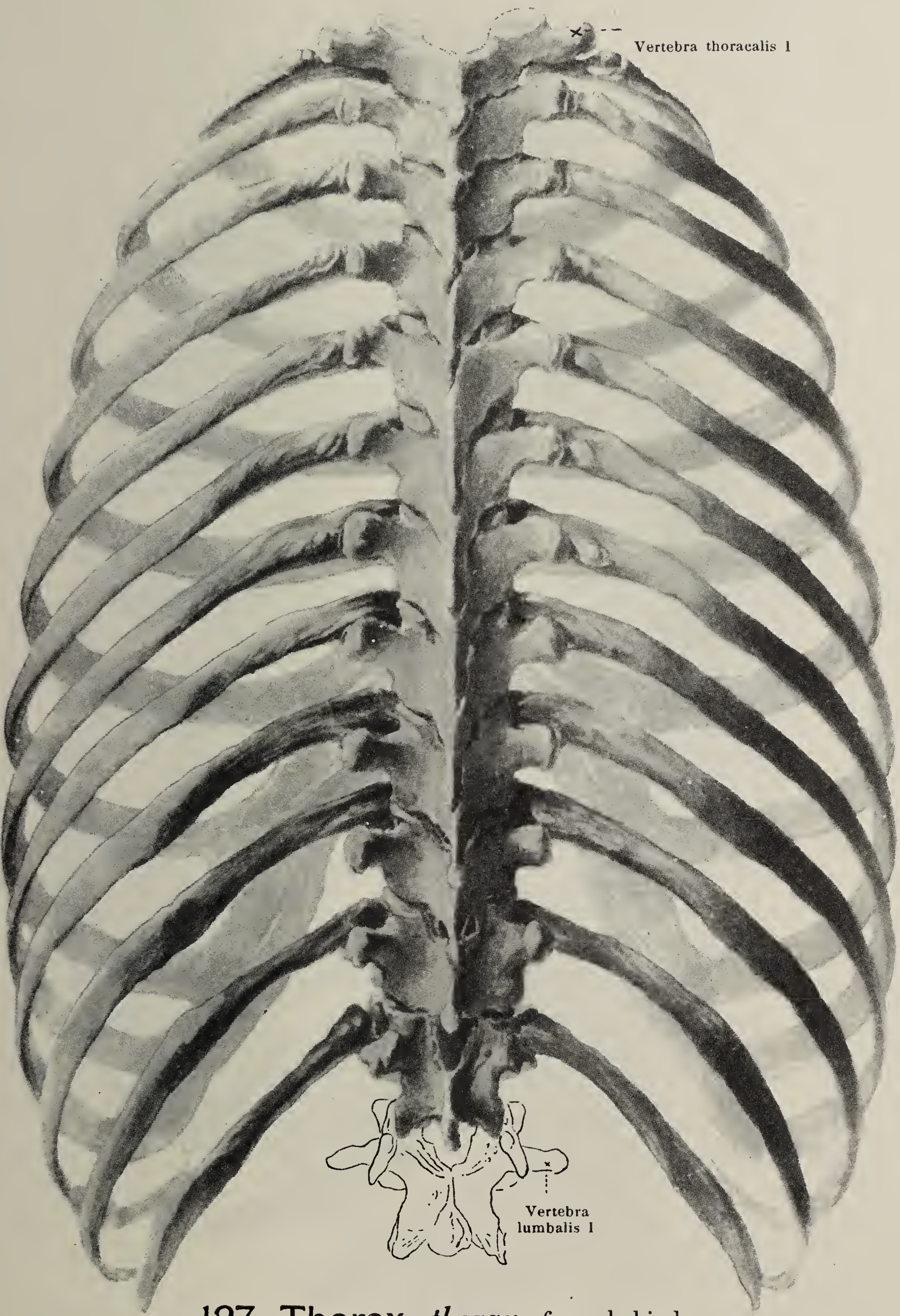
On each lateral surface of the manubrium and corpus are seven (sometimes eight, see p. 86) notches, *incisurae costales*, for the upper seven (eight) ribs. The uppermost is mostly rough, the others are smoothly covered with cartilage. The uppermost notch is in the manubrium just below the incisura clavicularis (see above); the second at the point of union of manubrium and corpus, each forming a half of it; the third on the corpus nearly in the middle of the whole length of manubrium + corpus; the fourth to the seventh (eighth) in the lower half, so that the inferior notches are closer and closer together, the two lowest often being fused to one; the seventh (and eighth) situated at the junction of the corpus with the processus xiphoideus may be situated partially in front of the latter.

In the female, other things being equal, the corpus sterni is shorter than in the male; accordingly, the female sternum is, on the whole, shorter and looks relatively broader and plumper.

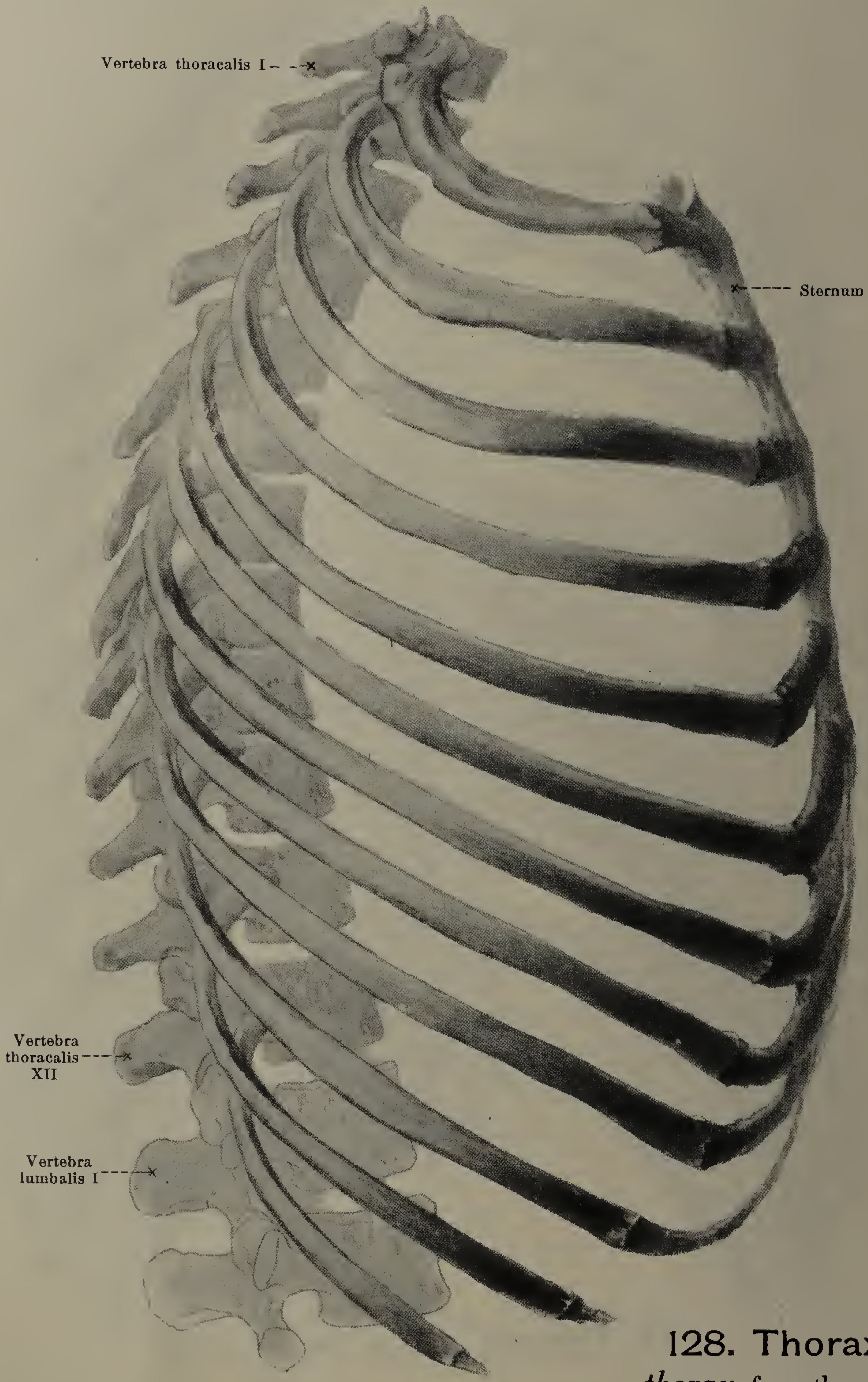
Breast bone, ribs and thoracic vertebrae combine with their ligaments to form the *thorax* (see Figs. 126—129). The cavity of the latter, the *cavum thoracis*, opens upward through the *apertura thoracis superior*, downward through the *apertura thoracis inferior.* The angle which is formed in the latter on both sides by the 7th and 8th costal cartilages and whose apex lies at the beginning of the proc. xiphoideus on the sternum is called the *angulus infrasternalis.*



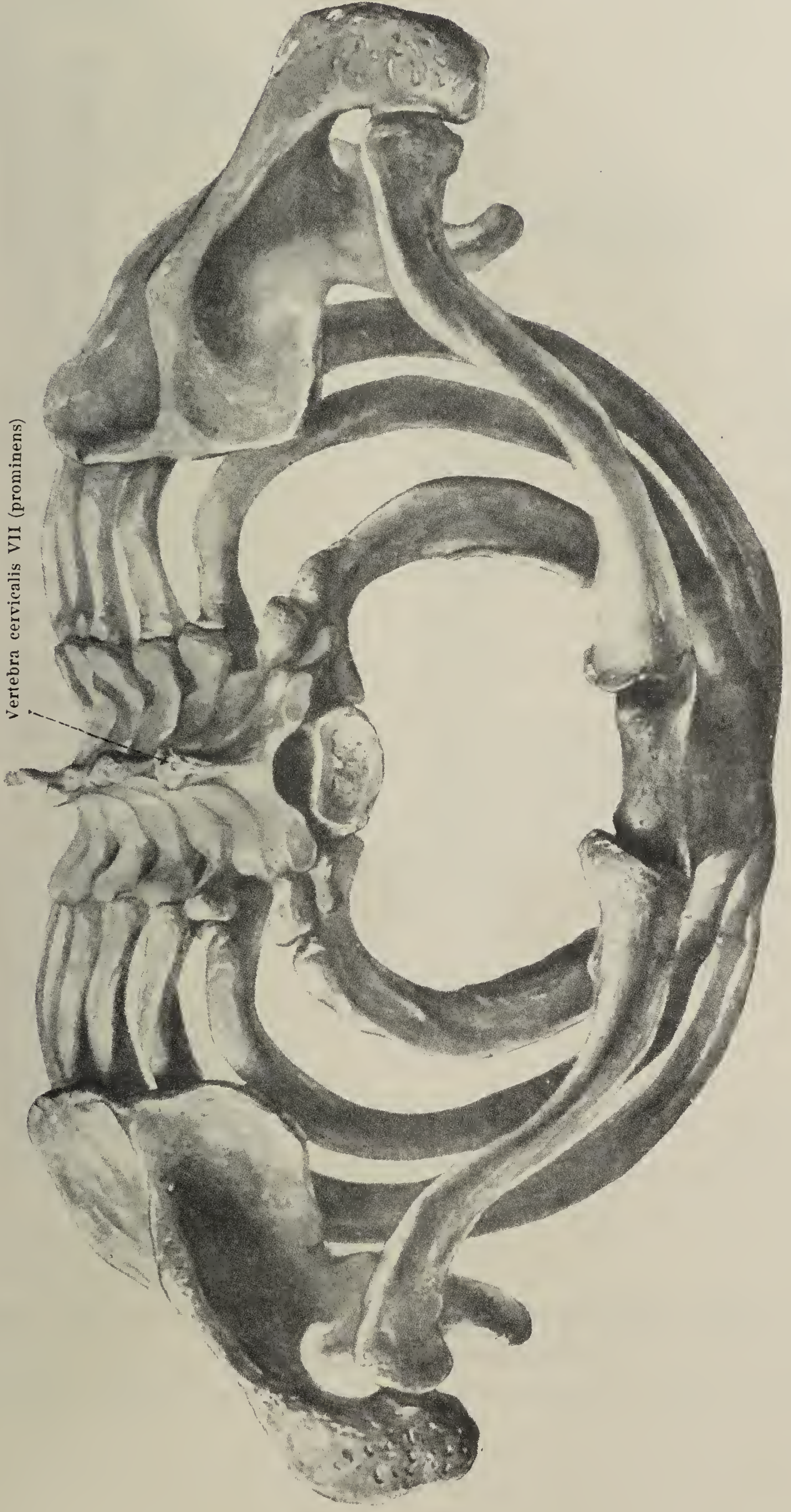
126. Thorax, *thorax,* from in front.



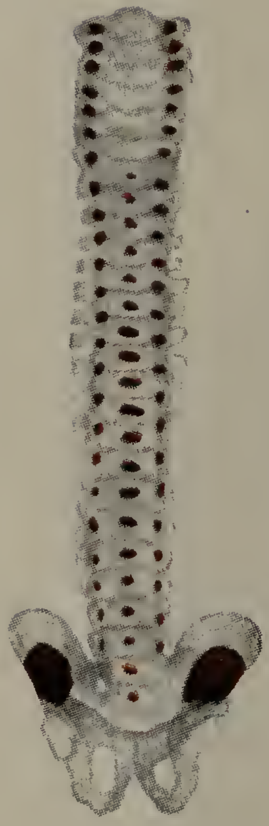
127. Thorax, ***thorax,*** from behind.



128. Thorax,
thorax, from the right.

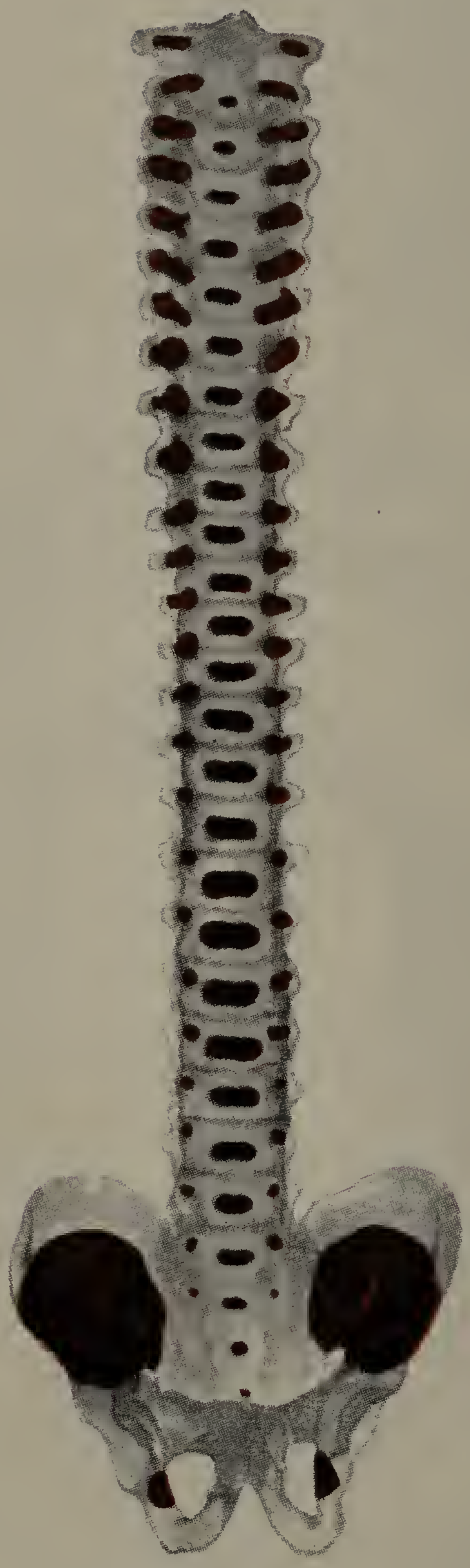


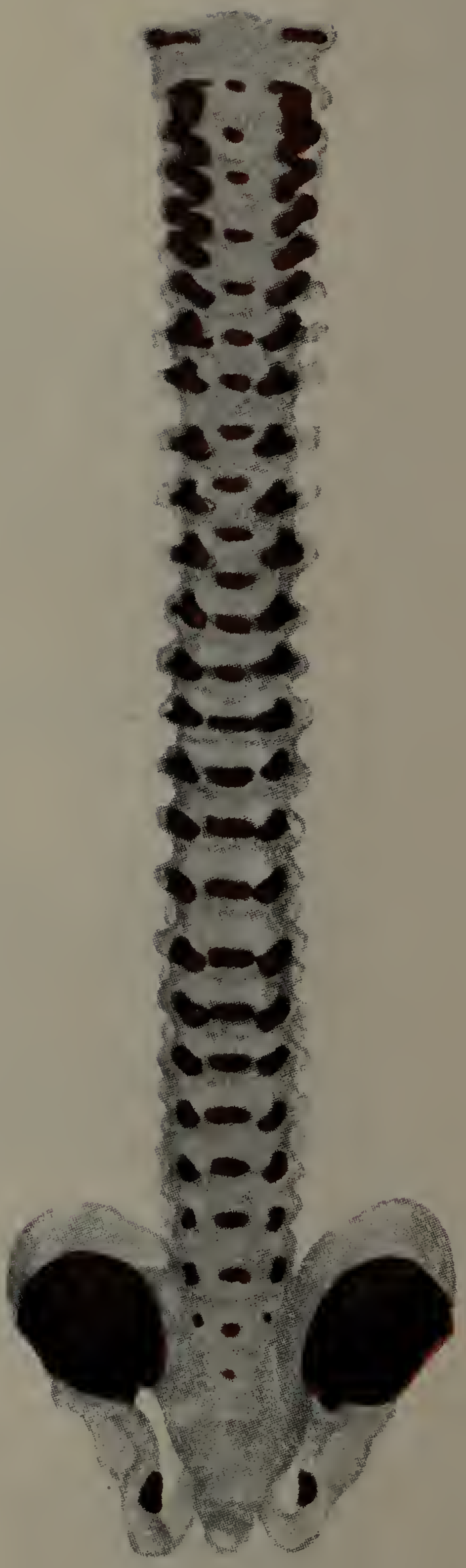
129. Thorax and Shoulder Girdle, viewed from above.



130. Fetus 8.5 cm long
(about 12 weeks),

from in front.

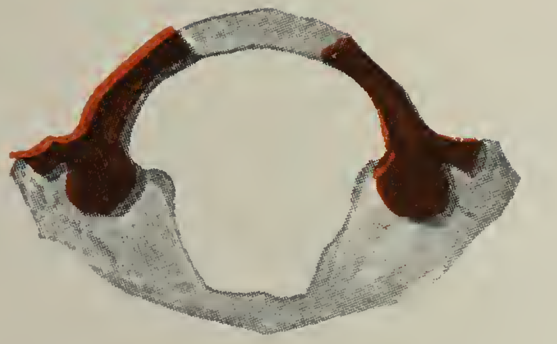




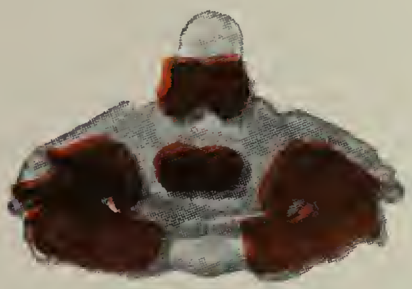
131 and 132. Fetus 18.5 cm long (about 17 weeks),
from in front. from behind.

130—132. Spinal Column and Pelvis of human fetuses. Magnif.: 3 : 2.

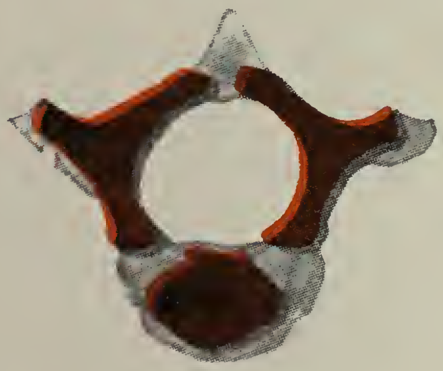
(The bone substance is collored red, the rest of the skeleton is made transparent.)



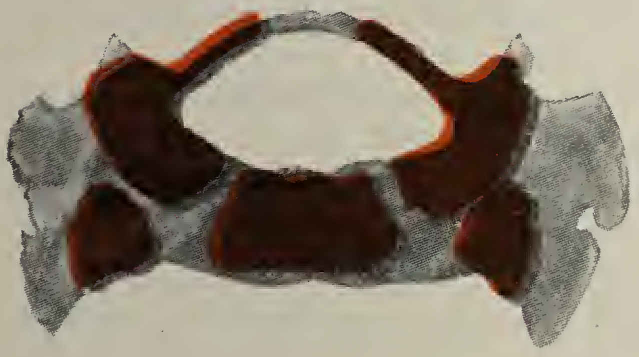
133. Atlas, viewed from above.



134. Epistropheus, from in front.



135. Middle dorsal vertebra, viewed from above.

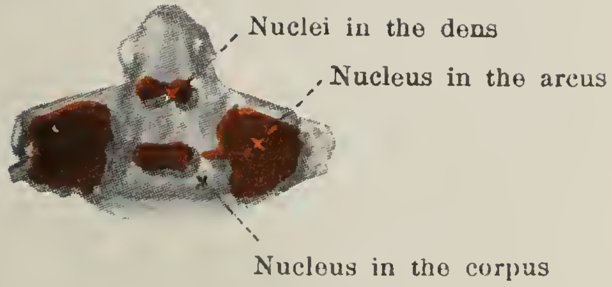


136. First sacral vertebra, viewed from above.

133—136. Vertebral bones of a newborn.

Magnif.: 3:2.

(The bone substance is red, the rest of the vertebrae transparent.)

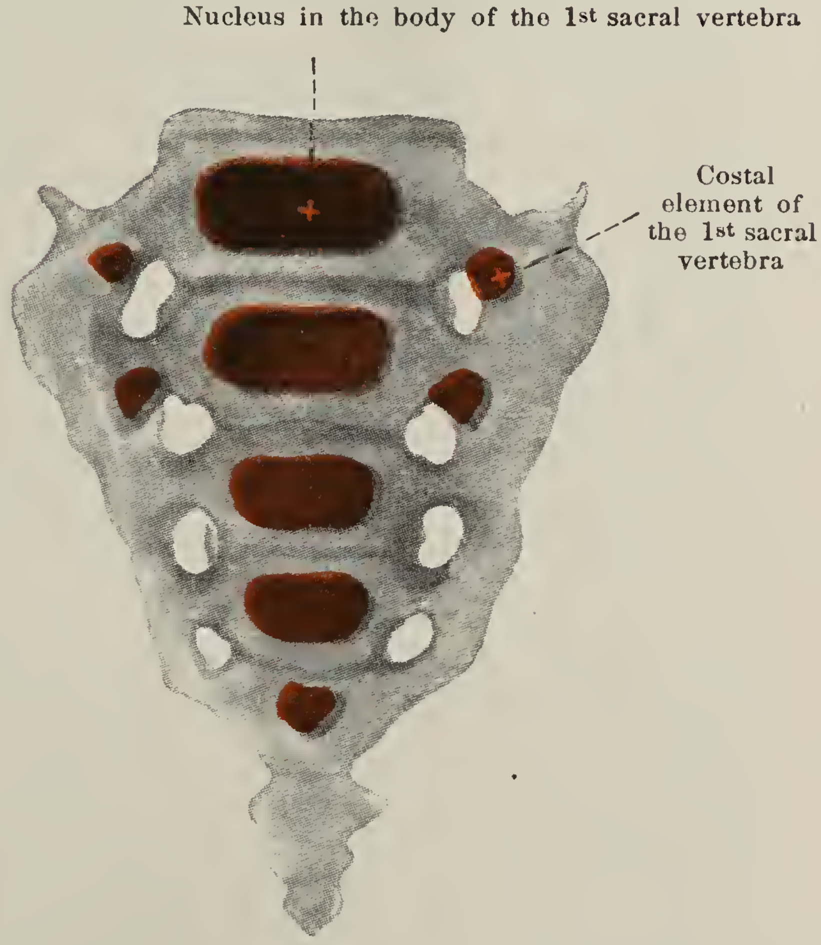


137.

Epistropheus of a fetus 6 months old,

from in front. Magnif.: 2:1.

(The bone substance is red, the rest of the vertebra transparent.)


Nucleus in the body of the 1st sacral vertebra
Costal element of the 1st sacral vertebra

138. Sacrum and Coccyx of an 8 month fetus,

from in front. Magnif.: 1:1.

(The bone substance is colored red, the rest is transparent. The nuclei in the arcus are not visible.)

The Development of the Bones of the Trunk.

All the bones of the trunk of the body are cartilaginous in origin.

The ***vertebrae*** (see Figs. 130—132 and 135). Each vertebra (with the exception of the coccyx) develops from three principal nuclei, one for the body of the vertebra and one for each half of the neural arch. The nuclei of the arches appear first (in the eighth week); they begin in the cervical vertebrae (from the second vertebra), and gradually continue downwards. The nuclei in the bodies of the vertebrae appear soon after, first in the lower dorsal and first lumbar vertebrae, and from there spreading upwards and downwards. The arch nuclei grow forward anteriorly into the body of the vertebra and form its dorsolateral portion; they also give arise to the main mass of the processes. At birth, the three nuclei are separated only by cartilage. The fusing together of the arch nuclei begins in the first year, and progresses rapidly upwards but slowly downwards. In the 3rd to 6th year there takes place the bony union of the arch nuclei with the body nuclei, beginning in the thoracic region.

About the time of puberty there appear on the upper and lower surfaces of each vertebra thin body epiphyses in the shape of rings or of plates which are very thin in the middle, and at the summits of the processus spinosi and transversi little cup-like epiphyses (usually double ones on the proc. spinosi of the cervical vertebrae), which do not fuse with the united main nuclei until the twentieth year of life.

Several of the vertebrae exhibit peculiarities.

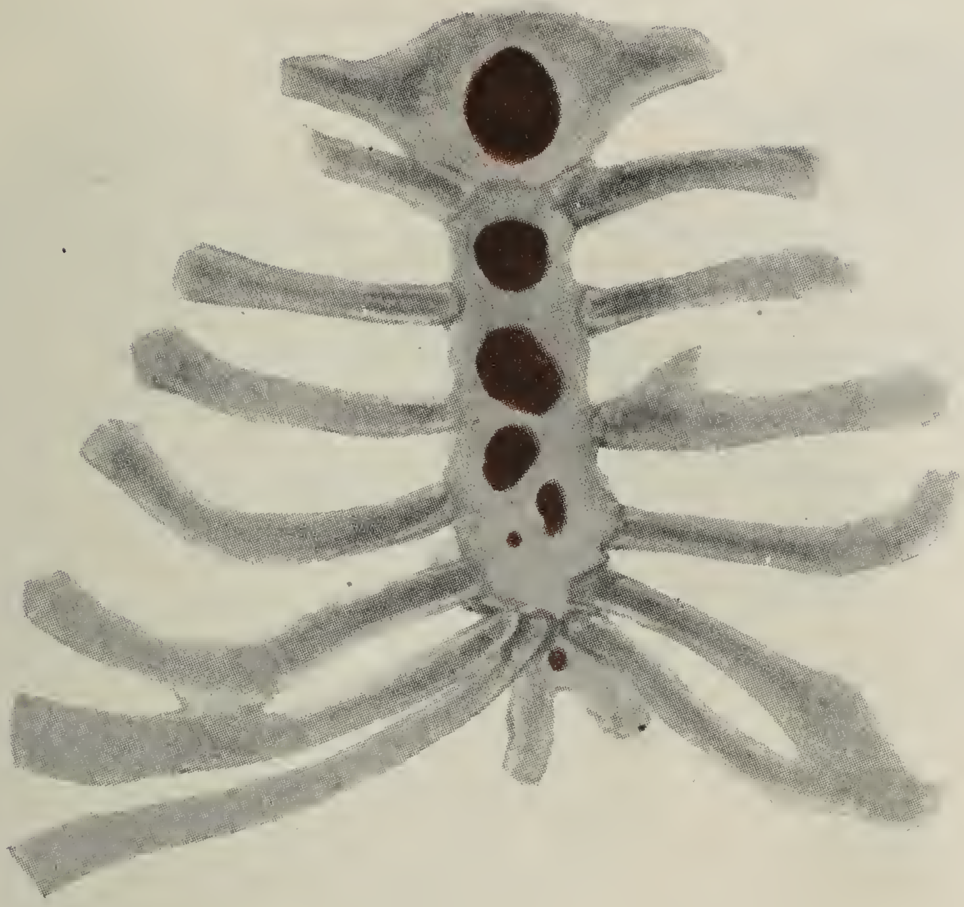
The *atlas* (see Figs. 130—133). The arcus posterior and the massae laterales ossify from two symmetrical centres (a right and a left one), which correspond to the centres of the neural arches of the other vertebrae and appear in the eighth week. In the arcus anterior there appears a nucleus (sometimes two) in the first year, which fuses with the two others in the fifth to ninth year. The dorsal nuclei unite in the third to fifth year.

The *epistropheus* (see Figs. 130—132, 134 and 137). The lower part of the body and the two halves of the neural arch each receive a nucleus like in the third cervical vertebra. In the fourth to fifth month there appear in the base of the dens and in the upper part of the body (inclusive of a small part of the facies articulares superiores) two symmetrical nuclei, which soon fuse with each other. The dens unites with the body and with the lateral parts and these unite with each other in the fourth to sixth year. At the tip of the dens there appears a special nucleus in the second year, which unites with the main mass in the twelfth year. The body receives an epiphysis only at its caudal end. A small cartilage disc remains inside the bone at the junction of the dens and the body until at advanced age.

On the *seventh vertebra* there appears very often in the second to fifth month a special nucleus in the ventral portion of the proc. tranversus, which usually unites with the body after birth, but sometimes remains separate, increases in length and may form a movable cervical rib.

The *lumbar vertebrae.* The procc. mamillares of the lumbar vertebrae, of the twelfth dorsal, and of the first sacral vertebra have at their summits special epiphyseal nuclei, which appear about the time of puberty or a little later and which grow together with the rest of the vertebra after the eighteenth year.

The *sacrum* (see Figs. 130—132 and 138). Each sacral vertebra develops (like every other vertebra) from three main centres or nuclei, one for the body and one for each half of the neural arch, which also forms the posterior part of the pars lateralis. The corpus nuclei appear in the first to third vertebra about the end of the third month, in the fourth and fifth about the fifth to eighth month; the lateral nuclei appear in the upper vertebrae in the fifth and sixth month. Besides these there are formed in the fifth to seventh month nuclei on the sides of the corpus in the three, more rarely four or two upper vertebrae, which represent costal elements, and form the section of the pars lateralis which bears the facies auricularis. The latter nuclei fuse with the nuclei of their corpus and arch in the second to fifth year; a little later the nuclei of the arch unite with the nucleus of the body. The lateral nuclei fuse with each other in the seventh to fifteenth year beginning above and progressing downwards. Besides these main nuclei there appear two epiphyseal plates for each body (about the fifteenth year) and two for each of the lateral borders of the sacrum, one for the facies auricularis and one for the rough caudal part of the border (between the eighteenth and twentieth year). There are furthermore epiphyses also for the processus spinosi.



139. The sternum and the true ribs of a fetus 7 months old. Magnification: 1:1.

(The bone substance is colored red, the rest is made transparent.)

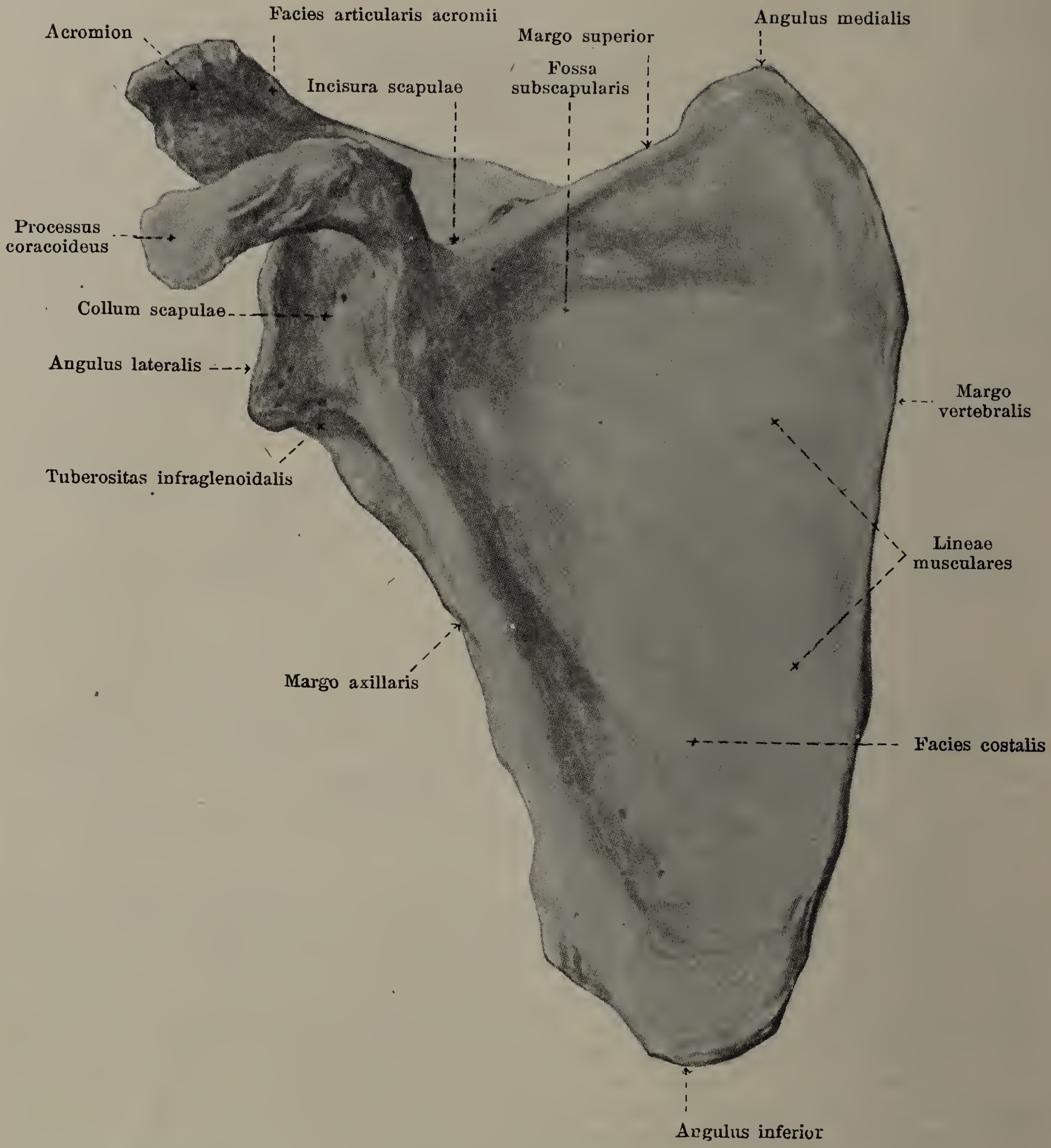
The *sacrum* (continned).

The five sacral vertebrae are separated from each other by cartilage until time of puberty. At that time the lateral portions of the vertebrae begin to grow together; then follows the fusion of the epiphyseal plates and the bodies and the ossification of the intervertebral discs. This process begins at the lower vertebrae and extends upward, so that the sacrum becomes a single bone about the twenty-fifth year; at the same time the lateral epiphyseal plates fuse also with the sacrum. Remains of the intervertebral discs are not infrequently found in adults.

The *coccyx.* Each coccygeal vertebra ossifies from one nucleus, of which the first one appears in the first year, the others much later, some not before puberty. The three lower ones unite usually about the thirtieth year.

The ***ribs.*** The centres of ossification first appear in the sixth and seventh ribs (about the end of the second month) earlier than in the vertebrae, and then extend rapidly to the other ribs, so that most of them have their nuclei at the end of the second month. The ossifying process begins in the region of the angulus costae and extends quickly to the head; the final relation between the costal bones and cartilages is reached in the fourth month. At the time of puberty there appear epiphyseal nuclei, one at each head and two at the tuberculum costae, which fuse with the corpus costae after the twentieth year.

The ***sternum*** possesses many centres of ossification, which vary extraordinarly both in regard to their place and time of appearance. The ossifying process usually begins with one nucleus in the manubrium in the third to sixth month; beside this one there often develop a number of accessory nuclei in the manubrium. Soon afterwards there begin to appear in the corpus five to seven partly paired and partly umpaired nuclei; those which lie most caudally, develop only after birth, in the first year of life. The nuclei of the corpus fuse together in irregular order in the sixth to twenty-fifth year, the lower frequently at an earlier stage than the upper. In the immediate vicinity of every incisura clavicularis there appears an epiphyseal nucleus which fuses with the manubrium in the twenty fifth to the twenty eigth year. The processus xiphoideus acquires a centre of ossification at its base, which usually appears in the sixth year or later.

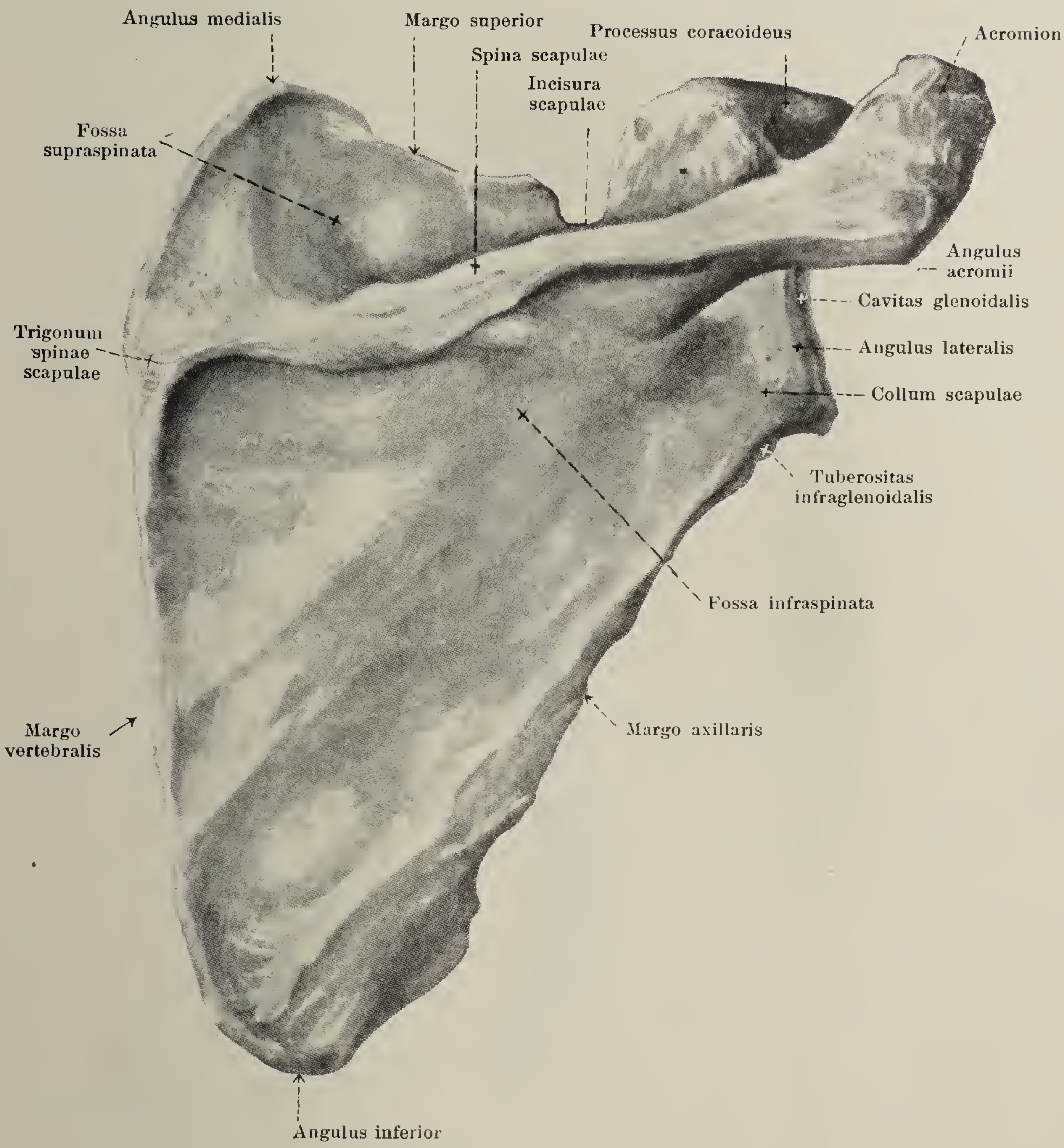


140. Right shoulder blade, *scapula,* from in front.

The **scapula** *(shoulder blade)* (see also figures 129, 141—144) is a broad, flat, thin, triangular bone which lies upon the upper part of the wall of the thorax so that the lateral angle projects lateralward over the thorax; its medial margin, when the arm is hanging down, runs in its lower portion nearly parallel to the median plane and extends from the second or third to the seventh or eighth rib. It lies freely movable between the muscles and is connected by joints lateralward with the clavicle and with the humerus only. (For development see p. 126.)

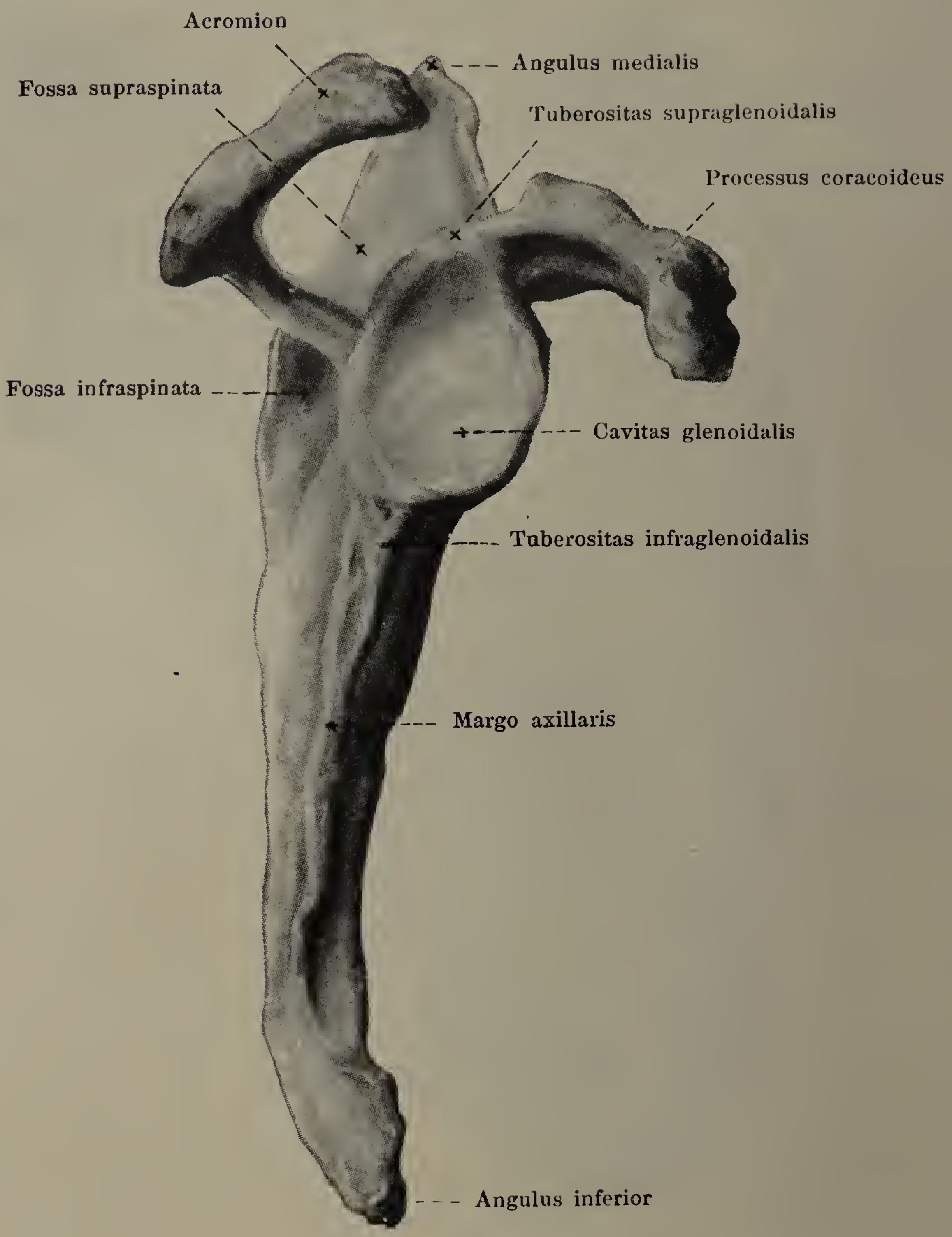
The shoulder blade has three margins: the thin, shortest, upper, *margo superior*, which presents on its lateral extremity a notch, the *incisura scapulae* (O. T. suprascapular notch); the longest, medial margin, *margo vertebralis*, whose upper part from the trigonum spinae scapulae onwards is generally somewhat bent over laterally; the thick, lateral margin, *margo axillaris.* These margins meet in three angles: the blunt, thick, *angulus inferior*, the sharper, thinner *angulus medialis* (O. T. superior angle) and the *angulus lateralis* (O. T. anterior angle); the latter supports the surface for articulation with the humerus (see p. 102).

The anterior surface, **facies costalis,** is markedly concave in its upper lateral part, forming the *fossa subscapularis;* in other parts it looks smooth except for several ridges, *lineae musculares*, directed toward the lateral angle, to which are attached tendinous bands of the m. subscapularis.



141. Right shoulder blade, *scapula,* from behind.

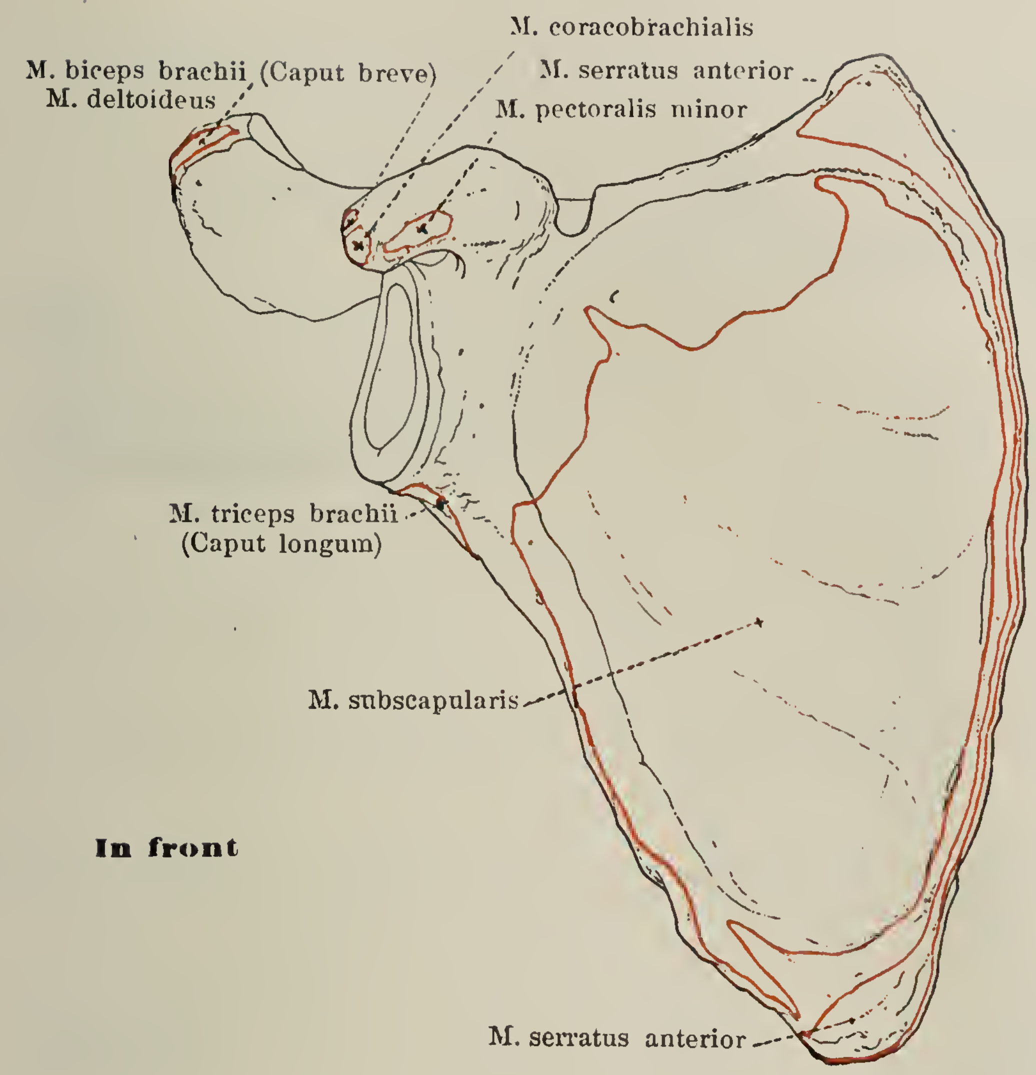
The posterior surface of the shoulder blade, **facies dorsalis scapulae**, is convex and subdivided by a bony projection, *spina scapulae*, which ascends at about the junction of the upper with the middle third, into the upper smaller, deeper *fossa supraspinata* and the lower, larger, flatter *fossa infraspinata.* The spina scapulae begins with a small, three-cornered, flat area *(trigonum spinae scapulae)* at the margo vertebralis and develops gradually to a very powerful high plate of bone which possesses an upper surface, directed also somewhat forward, and a lower surface, looking also somewhat backward. The free margin is broad. A strong process (the *acromion*) goes off from the side of it, first lateralward, then forward; it looks flattened out in its most anterior part and presents an upper an a lower surface, is blunt at the front or terminates straight. The superior edge of the free margin of the spina scapulae goes over in a flat bow in the medial edge of the acromion and near its apex it presents medianward a small oval *facies articularis acromii* for articulation with the facies articularis acromialis claviculae; the lower edge forms with the lateral edge of the acromion usually an angle. The pointed part of the acromion in the adult is rarely separated by cartilage from the rest of the bone.

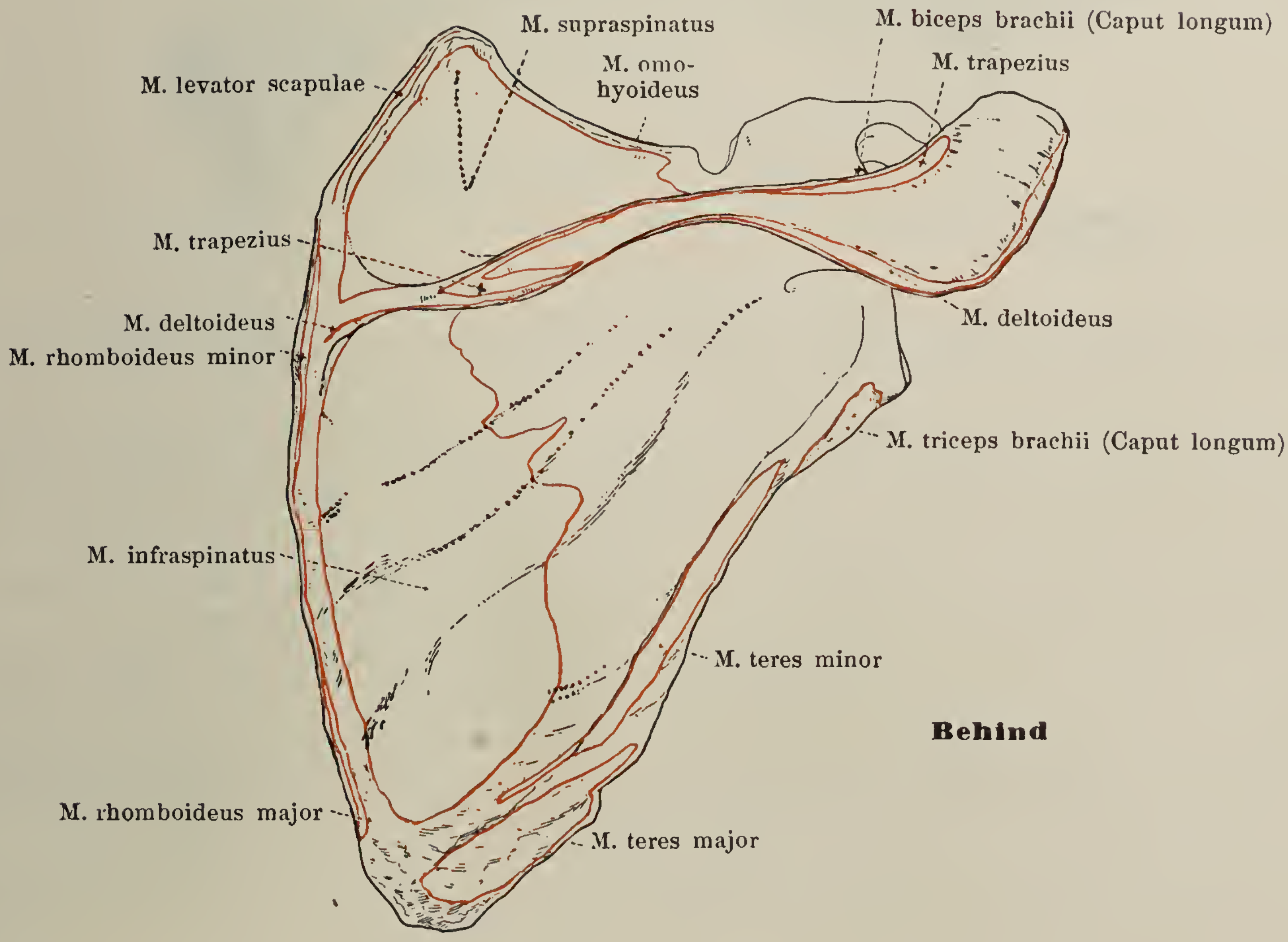


142. **Right shoulder blade,** *scapula,* from without.

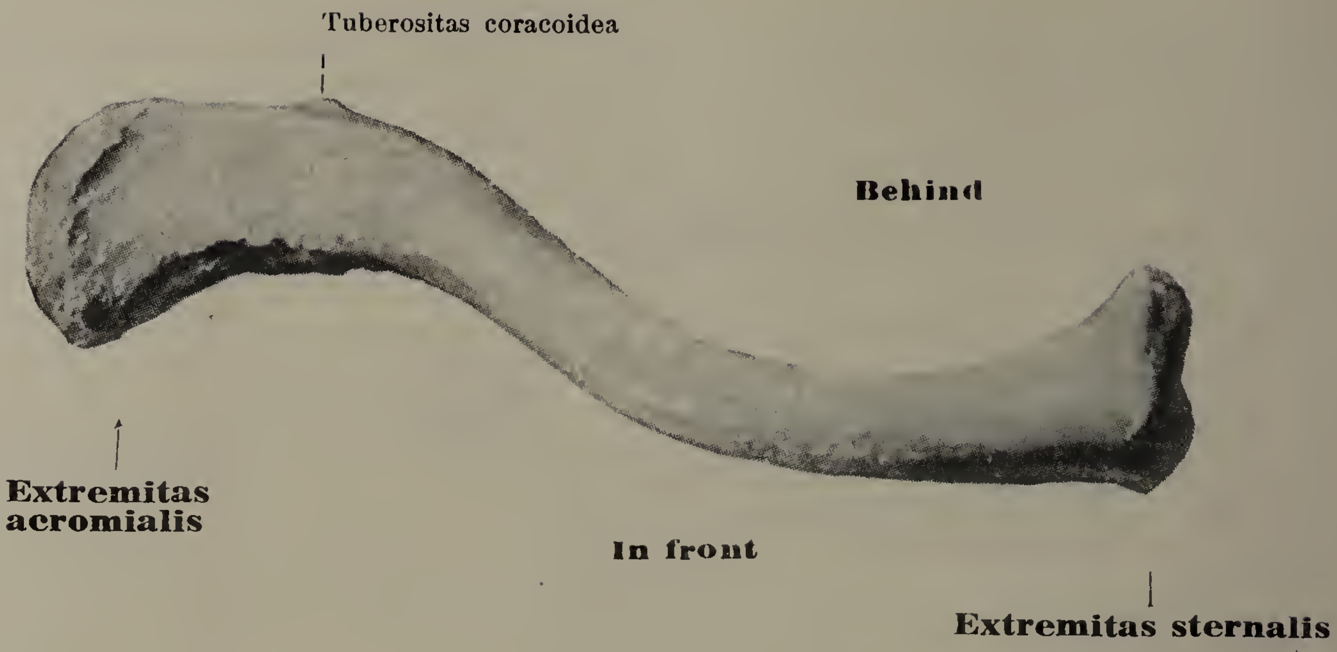
The **angulus lateralis scapulae** becomes markedly broader externally and is marked off from the rest of the shoulder blade by a shallow groove or neck, *collum scapulae.* The surface which is turned lateralward, the *cavitas glenoidalis,* is somewhat concave and is covered with cartilage; it is nearly oval in shape and is broader below than above; there is a slight indentation in the upper part of the anterior margin. A roughness just above this, the *tuberositas supraglenoidalis* (O. T. supraglenoid tubercle), gives origin to the caput longum m. bicipitis; another, larger, below it, at the uppermost end of the margo axillaris, *tuberositas infraglenoidalis,* gives origin to the caput longum m. tricipitis.

Between the cavitas glenoidalis and the incisura scapulae, arising from the margo superior, is the *processus coracoideus (crow's beak process);* it is thick, rounded, runs first forward and upward, then, making a marked hook-like curve, forward and lateralward and ends in a blunt tip. Very rarely it is separate from the rest of the bone.

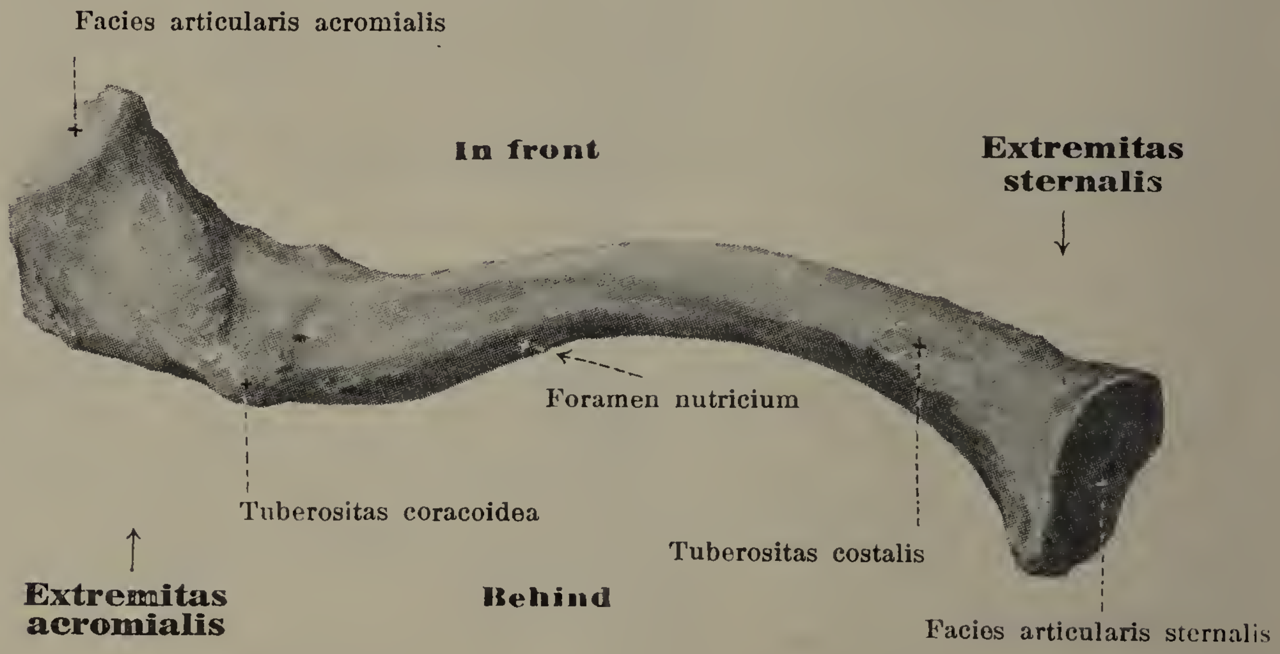




143 and 144. Right shoulder blade, ***scapula,***
from in front, with the muscular attachments.



145. Right collar bone or clavicle, *clavicula,* from above.

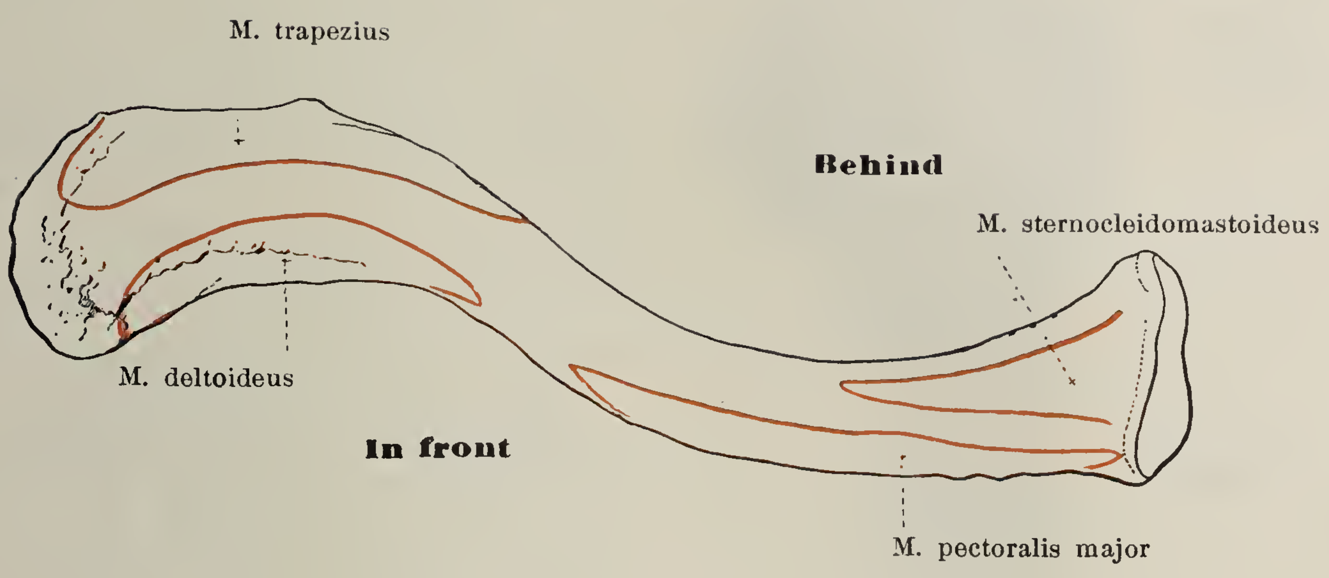


146. Right collar bone or clavicle, *clavicula,* from below.

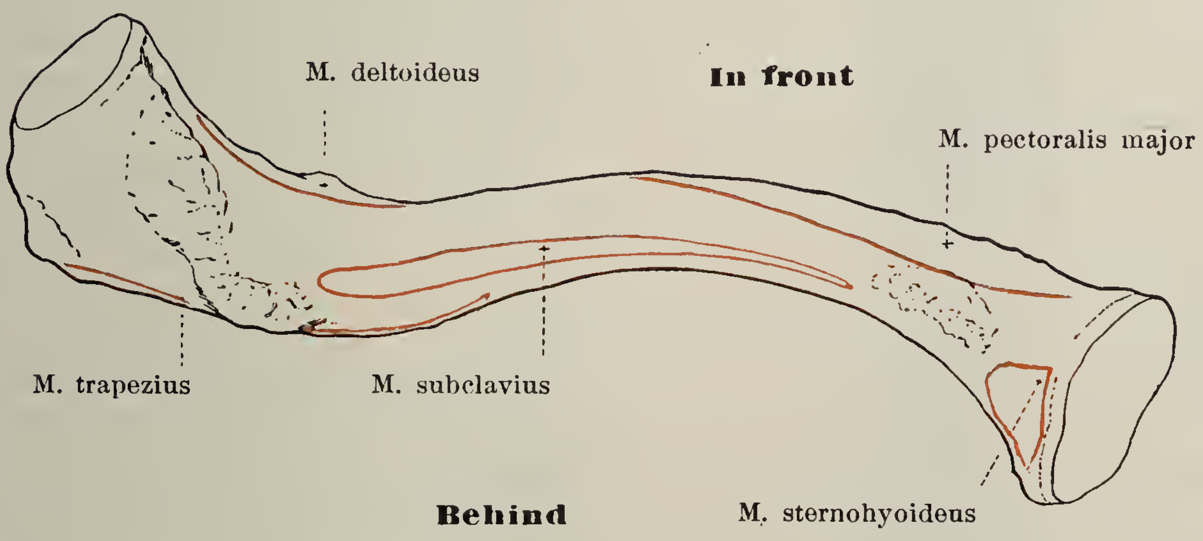
The **clavicula** *(key, clavicle or collar bone)* (see also Fig. 129) is a short, strong, cylindrical bone bent ∽-like which runs transversely in front of the first rib, going out on each side from the upper end of the sternum, and is attached at its lateral extremity to the acromion scapulae. (For development see p. 126.)

It is divisible into a shaft and two extremities: that directed toward the sternum, *extremitas sternalis,* and that looking toward the scapula, *extremitas acromialis.*

The shaft is bent convexly forward in its medial half; in its lateral half convexly backward. It is triangular with rounded angles especially medianward; one surface is directed in front and upward, another in front and downward, and a third backward. The extremitas sternalis is thickened and ends with the approximately triangular, curved *facies articularis sternalis* covered with fibrocartilage, which lies in the incisura clavicularis sterni. Somewhat lateralward from it, at the junction of the anterior inferior with the posterior surface, the *tuberositas costalis* (O. T. impression for rhomboid ligament) (for the lig. costoclaviculare) is visible. The extremitas acromialis is somewhat broadened and is flattened from above downward; at its extreme end it is turned somewhat forward and supports there the small, oval, flat *facies articularis acromialis* for articulation with the facies articularis acromii scapulae. Just medianward, near this, on the lower surface lies the oblong, rough *tuberositas coracoidea* (O. T. impression for conoid ligament) (for the lig. coracoclaviculare).



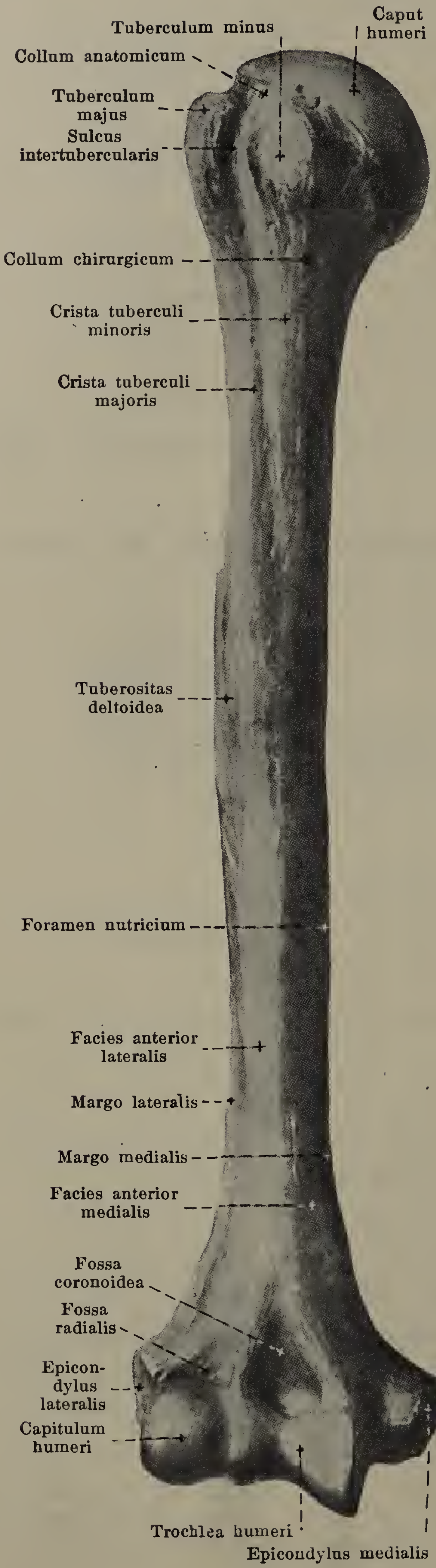
147. Right collar bone or clavicle, ***clavicula,*** from above, with the muscular attachments.



148. Right collar bone or clavicle, ***clavicula,*** from below, with the muscular attachments.

149. Right humerus,

humerus, from in front.



The **humerus** *(upper arm bone)* (see also Figs. 150—155) is a long cylindrical bone which articulates above with the shoulder blade, below with the bones of the forearm. (For development see p. 126.)

It is divisible into a *body* or shaft, *corpus humeri,* and two extremities.

The ***corpus* humeri** *(shaft)* is more cylindrical above, distinctly triangular below; its surfaces are called the *facies posterior,* the *facies anterior medialis* (O. T. internal surface) and the *facies anterior lateralis* (O T. external surface); the posterior surface is separated from the two anterior surfaces by the *margo medialis* (O. T. internal border) and the *margo lateralis* (O. T. external border) both of these being especially sharp and prominent below. On the facies anterior lateralis somewhat above the middle is a broad rough surface, *tuberositas deltoidea* (for the m. deltoideus); behind this, on the posterior surface lies a shallow groove, the *sulcus nervi radialis* (O. T. musculospiral groove) (for the n. radialis), which begins on the medial margin and descends like a long drawn-out spiral to the lateral margin. A large *foramen nutricium* is often noticeable near the middle on the medial margin; it leads into a *canalis nutricius* directed distalward.

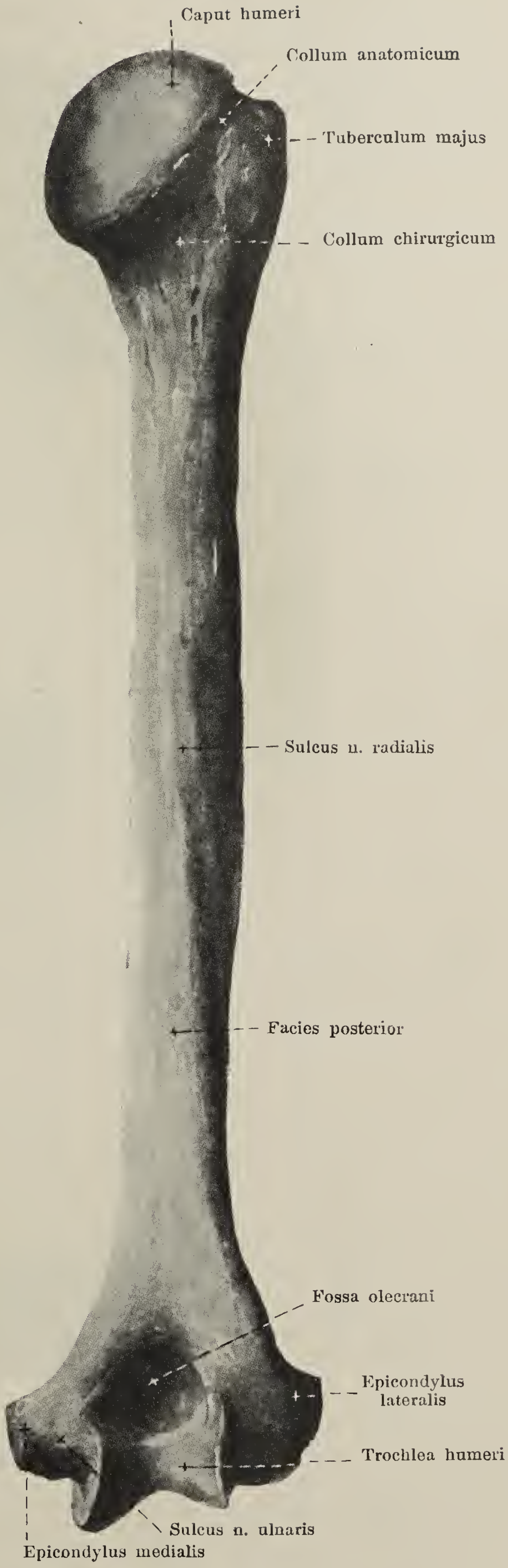
The ***upper extremity*** is broadened and supports the *caput humeri* which is covered with cartilage; this is nearly hemispherical and directed upward and medianward. It is separated from the rest of the bone by a constriction, the *collum anatomicum (anatomical neck).* Close to this lie two eminences: directed exactly lateralward is the *tuberculum majus* (for the mm. supraspinatus, infraspinatus and teres minor); in front of this directed forward the *tuberculum minus* (for the m. subscapularis); running forward and downward from both of these are ridges, the *crista tuberculi majoris* (for the m. pectoralis major) and the *crista tuberculi minoris* (for the mm. teres major and latissimus dorsi). Between the tubercula and the cristae runs the deep *sulcus intertubercularis (bicipital groove),* covered over with cartilage, (for the tendon of the caput longum m. bicipitis). At the junction of the upper extremity with the corpus humeri lies the *collum chirurgicum (surgical neck).*

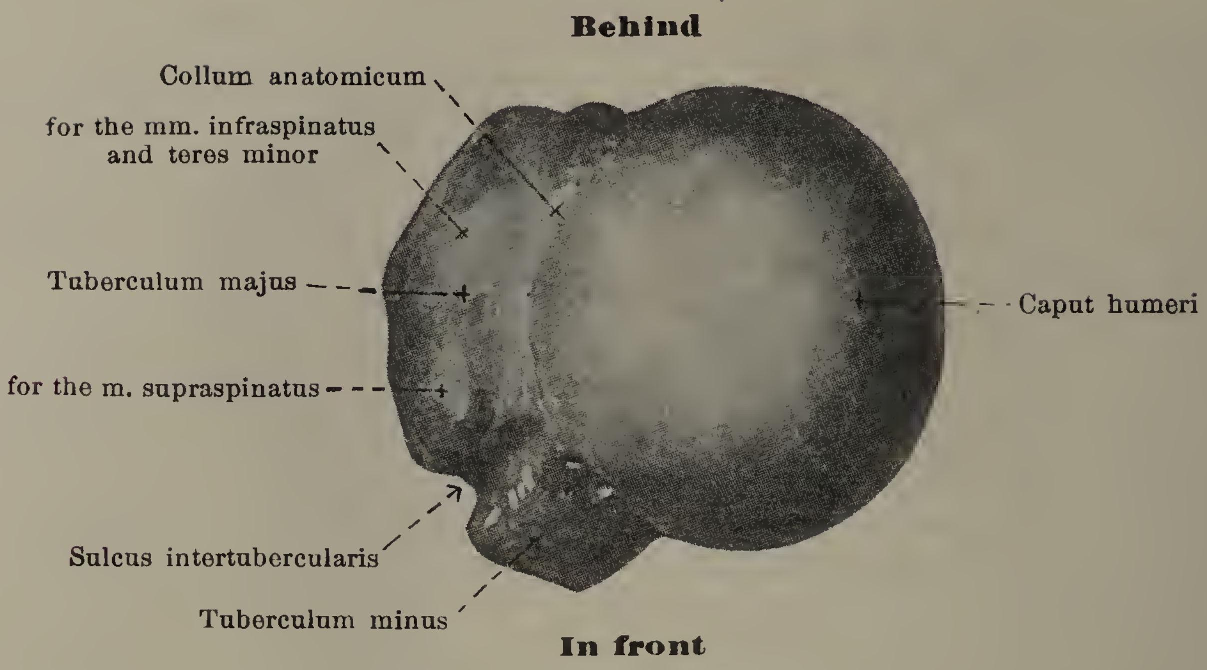
150. Right humerus,

humerus, from behind.

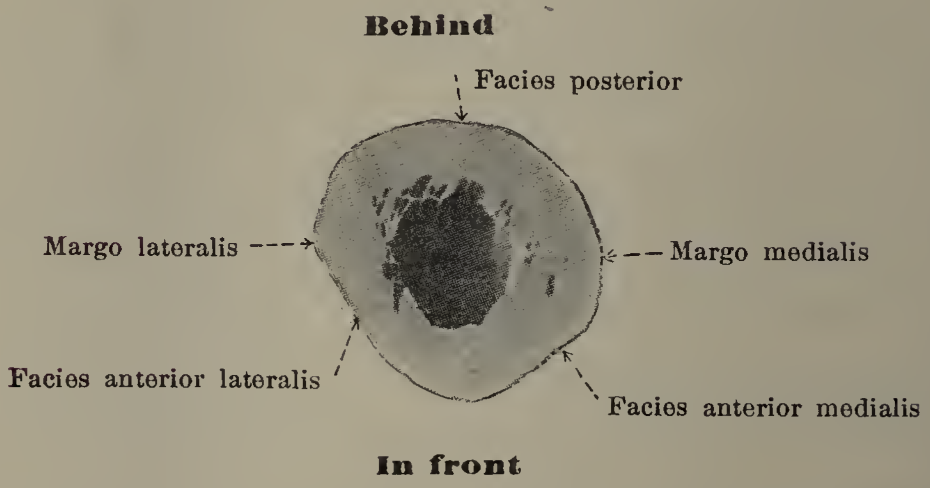
The ***lower extremity*** *of the* **humerus** is somewhat thinner but broader than the shaft. From each side of it projects a rough eminence, the *epicondylus medialis* (O. T. internal condyle) and the *epicondylus lateralis* (O. T. external condyle). These lie in the lines of continuation of the margo medialis and the margo lateralis and give attachment to muscles and ligaments of the elbow joint. The epicondylus medialis is the larger and presents on its posterior surface a shallow groove, *sulcus nervi ulnaris* (for the n. ulnaris).

Between the two epicondyles lies the joint surface, covered with cartilage, for articulation with the bones of the forearm, the axis of which is in a little oblique relation to the long axis of the corpus humeri. The articular surface consists of a medial, roller-shaped surface, *trochlea humeri* (for articulation with the ulna), which extends also upon the posterior surface, and of a lateral, smaller *capitulum humeri* (O. T. capitellum or radial head) (for articulation with the radius), shaped like the segment of a sphere, which is not continued upon the posterior surface. Above the trochlea, both in front and behind, is a deep depression; that in front is called the *fossa coronoidea,* that behind, the *fossa olecrani;* between the two the bone is very thin and may be absent. On the anterior surface, above the capitulum humeri, lies the smaller *fossa radialis.* These three depressions are not covered with cartilage.

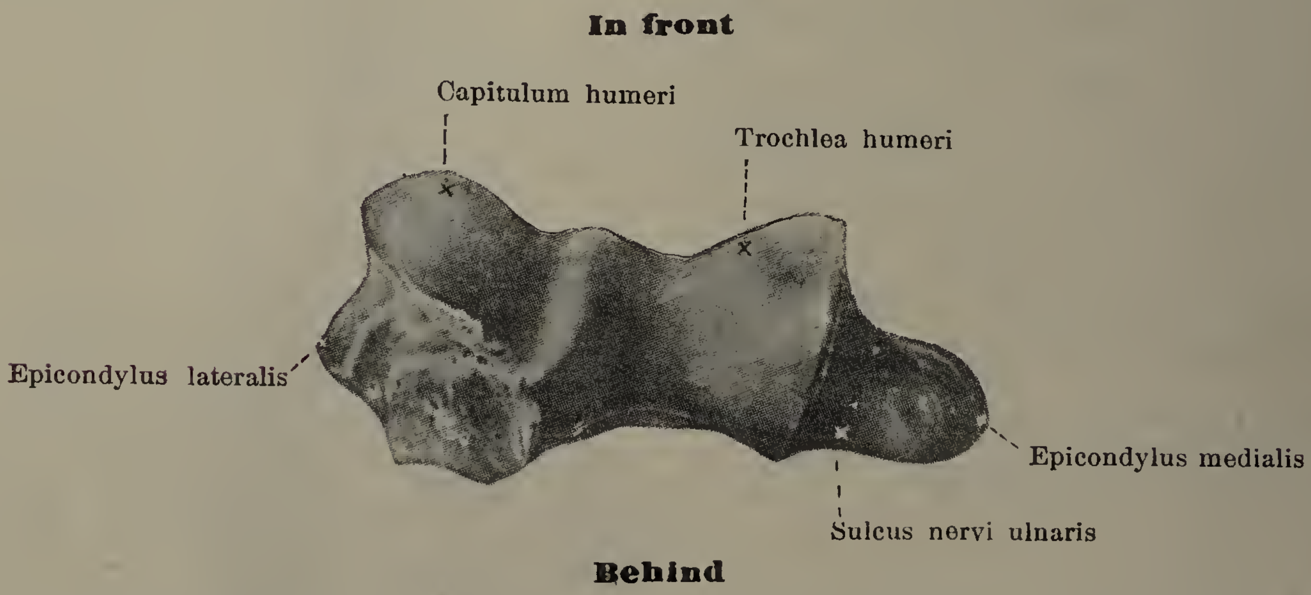




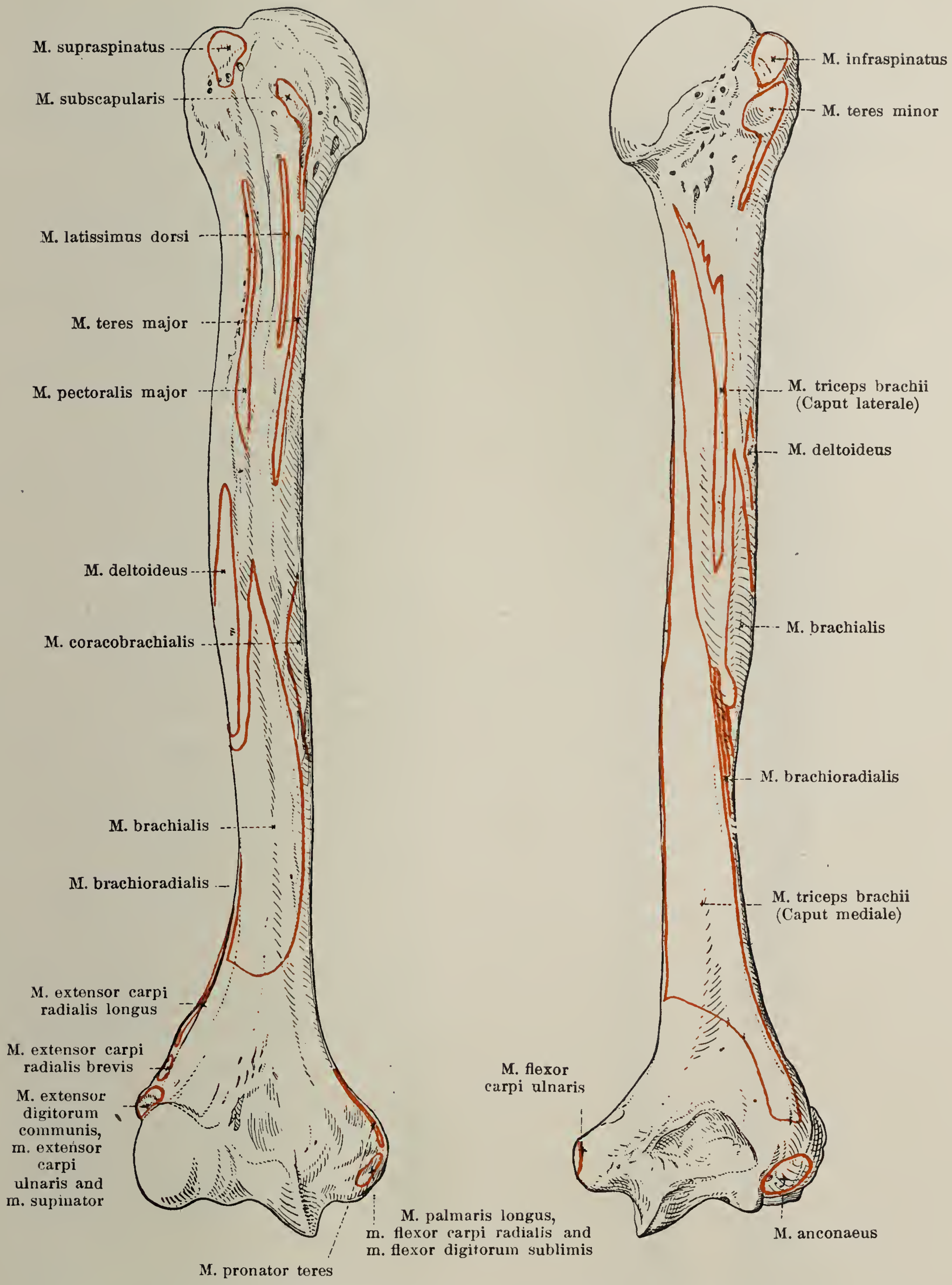
151. Right humerus, *humerus,* upper extremity, from above.



152. Transverse section through the lower half of the right humerus.



153. Right humerus, *humerus,* lower extremity, from below.


M. supraspinatus
M. subscapularis
M. latissimus dorsi
M. teres major
M. pectoralis major
M. deltoideus
M. coracobrachialis
M. brachialis
M. brachioradialis
M. extensor carpi radialis longus
M. extensor carpi radialis brevis
M. extensor digitorum communis, m. extensor carpi ulnaris and m. supinator
M. pronator teres
M. palmaris longus, m. flexor carpi radialis and m. flexor digitorum sublimis
M. flexor carpi ulnaris
M. infraspinatus
M. teres minor
M. triceps brachii (Caput laterale)
M. deltoideus
M. brachialis
M. brachioradialis
M. triceps brachii (Caput mediale)
M. anconaeus

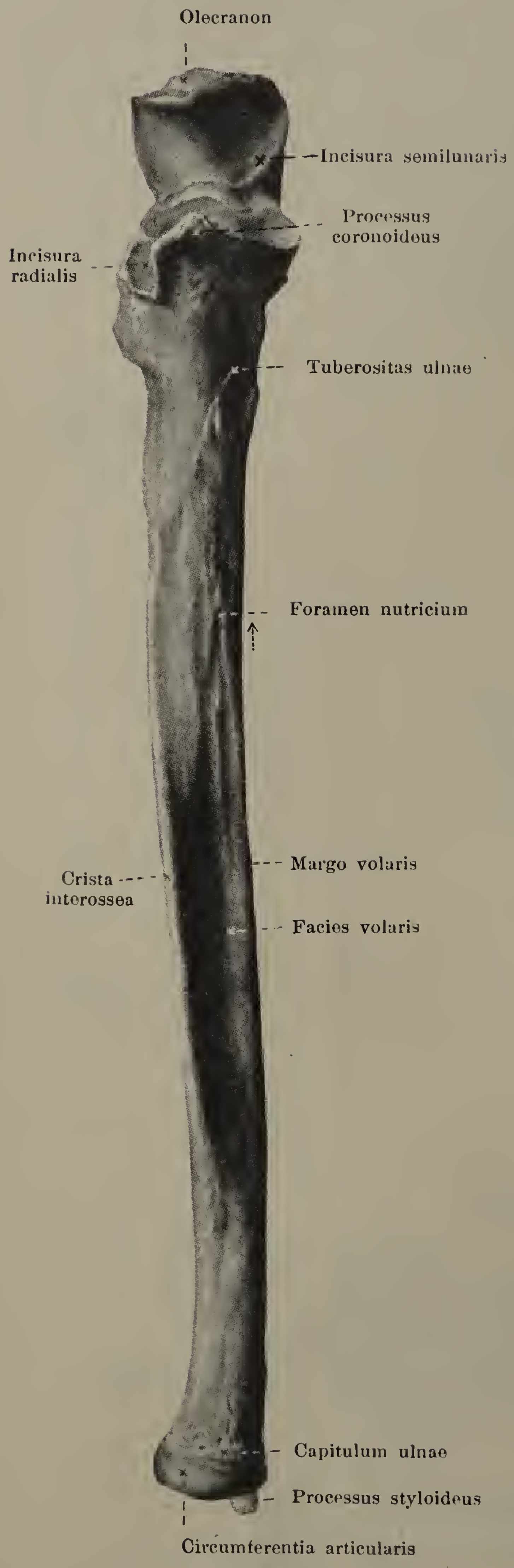
154 and 155. Right humerus, *humerus*,

with muscular attachments,

from in front. from behind.

156. Right ulna, *ulna*,

from in front.



The skeleton of the forearm, **antebrachium,** consists of two bones, **ulna** and **radius,** rotatably connected with one another at their upper and lower extremities. These two bones either lie approximately parallel to each other (see Figs. 162, 163 and 288); the volar surface is then directed forward (the hand is supinated). Or the radius lies obliquely over the ulna; in this case the volar surface of the hand faces backward (the hand is pronated). In the middle position, the arm hanging down, the volar surface of the hand faces the median plane (see Figs. 1 and 2). The description is usually based on the supination position.

The **ulna** (see also Figs. 157, 161—163, 179) is a long, cylindrical bone which is thicker at its upper than at its lower extremity. It lies on the side of the forearm corresponding to the little finger, is united above by a joint with the upper arm, below, only indirectly, with the carpus; it is united by joints with the radius both above and below. (For development see p. 126).

It is divisible into a shaft or *corpus*, and two extremities.

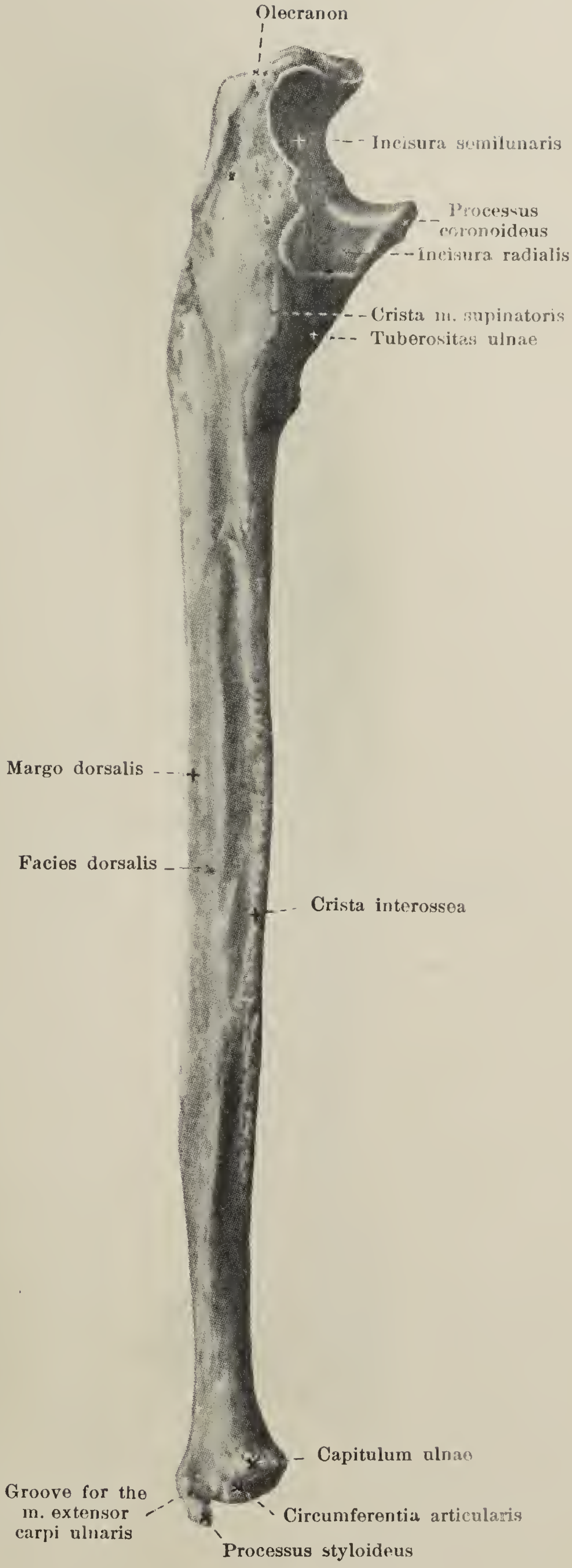
The *shaft*, ***corpus* ulnae,** is bent slightly so as to be convex toward the side of the little finger and is triangularly prismatic. Of its three surfaces, the *facies medialis* (O. T. internal surface) on the side corresponding to the little finger is narrow; it goes over at the rounded *margo volaris* (O. T. anterior border) in front and the *margo dorsalis* (O. T. posterior border) behind, into the broader *facies volaris* (O. T. anterior surface) and *facies dorsalis* (O. T. posterior surface). These meet with their radial borders in the sharply projecting *crista interossea* (O. T. external or interosseous border). A *foramen nutricium* often lies near the crista interossea at the middle of the length of the volar surface and leads into a *canalis nutricius* directed proximalward.

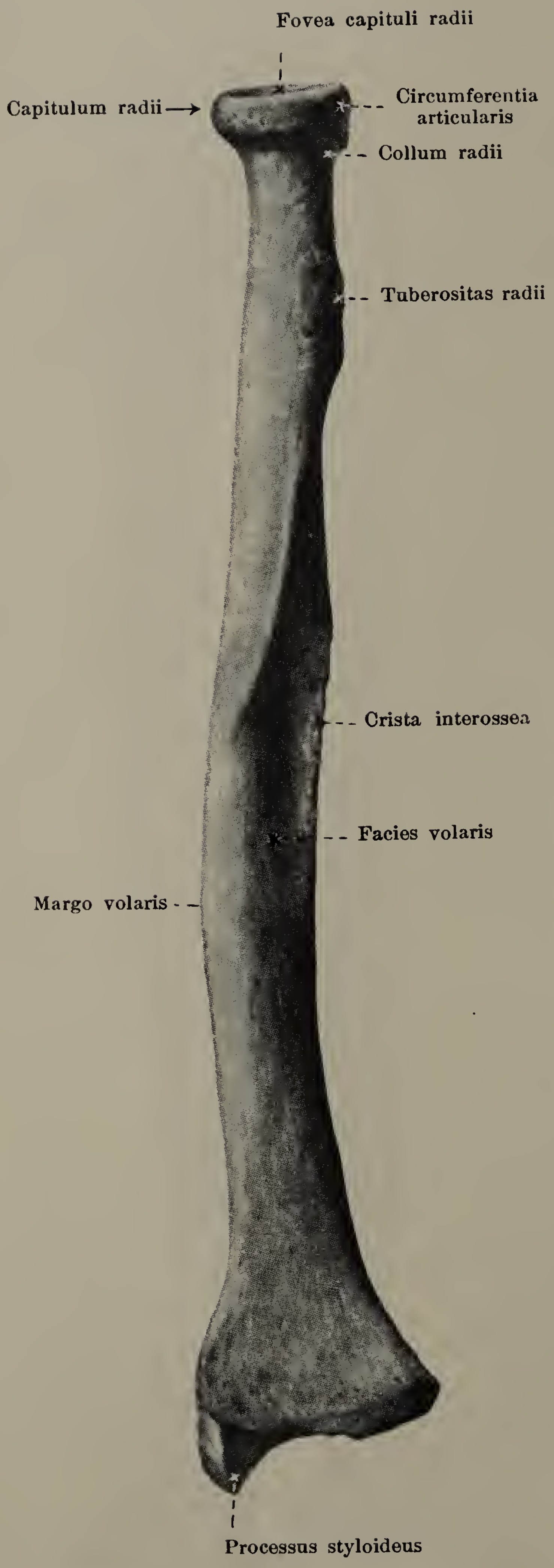
157. Right ulna, *ulna,*

from the radial side.

The ***upper extremity*** of the **ulna** is thickened and ends with a rough strong process, the *olecranon (elbow),* having a proximal, rough surface (behind to the attachment of the m. triceps brachii) and a smooth dorsal, triangular field that projects in a point into the margo dorsalis. Beneath it, projecting cornice-like from the volar surface, is the strong *processus coronoideus.* Between these two processes lies a deep notch, covered with cartilage sometimes broken by a cross-furrow, the *incisura semilunaris* (O.T. greater sigmoid cavity), in which the trochlea humeri is received. On the radial side of the proc. coronoideus the smaller, slightly concave *incisura radialis* (O. T. lesser sigmoid cavity) (for the capitulum radii) is visible. Passing obliquely backward and downward from this is a sharp bony ridge, the *crista m. supinatoris* (for the origin of the m. supinator). Somewhat below the proc. coronoideus lies a broad rough surface for the attachment of the m. brachialis, the *tuberositas ulnae.*

The ***lower extremity*** is narrower and forms a small rounded head, *capitulum ulnae.* This is covered with fibrocartilage not only on its distal surface but also in the largest part of its circumference, the *circumferentia articularis* (for the incisura ulnaris radii). On the dorsal side, the small blunt *processus styloideus* projects distalward.





158. Right radius,

radius, from in front.

The **radius** *(spoke)* (see also Figs. 159—163, 180) is a long cylindrical bone, thickened at its lower end which occupies the side of the forearm corresponding to the thumb. It articulates above with the humerus, below enters into the joint between the bones of the forearm and those of the carpus and rotates above and below on the ulna. (For development see p. 126.)

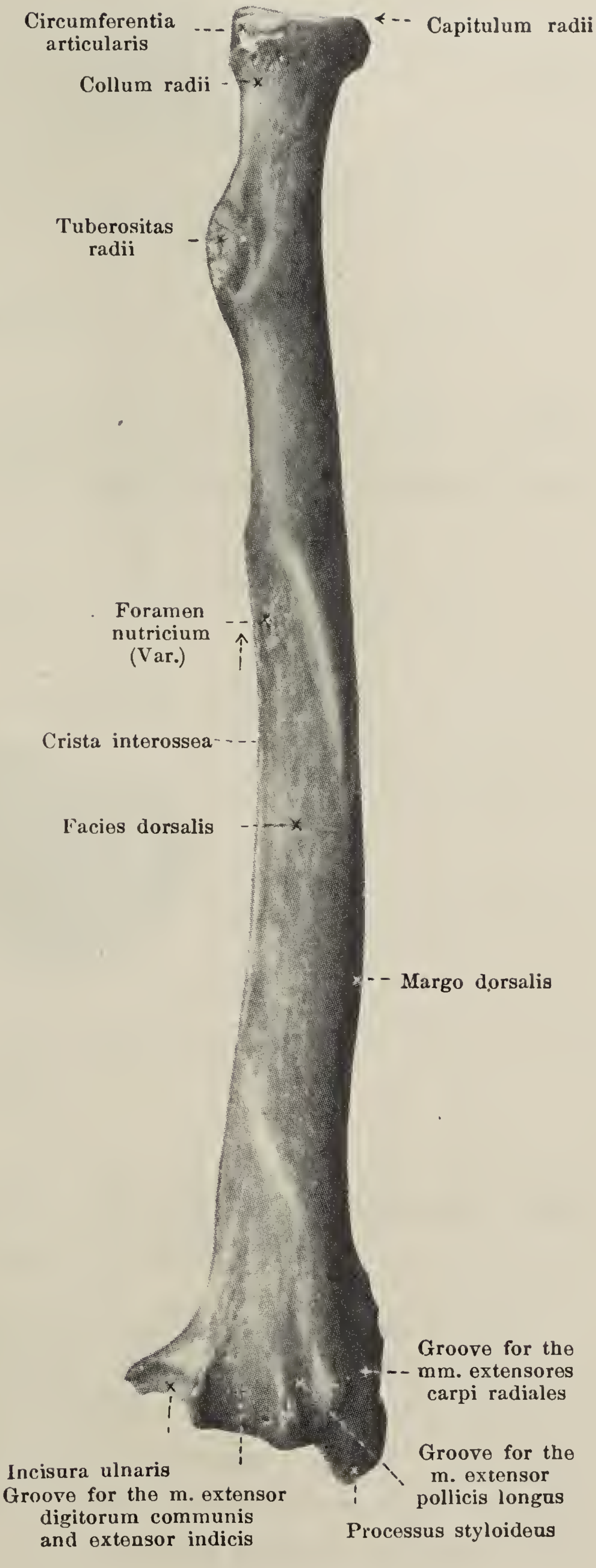
It is divisible into a shaft or *corpus* and two extremities.

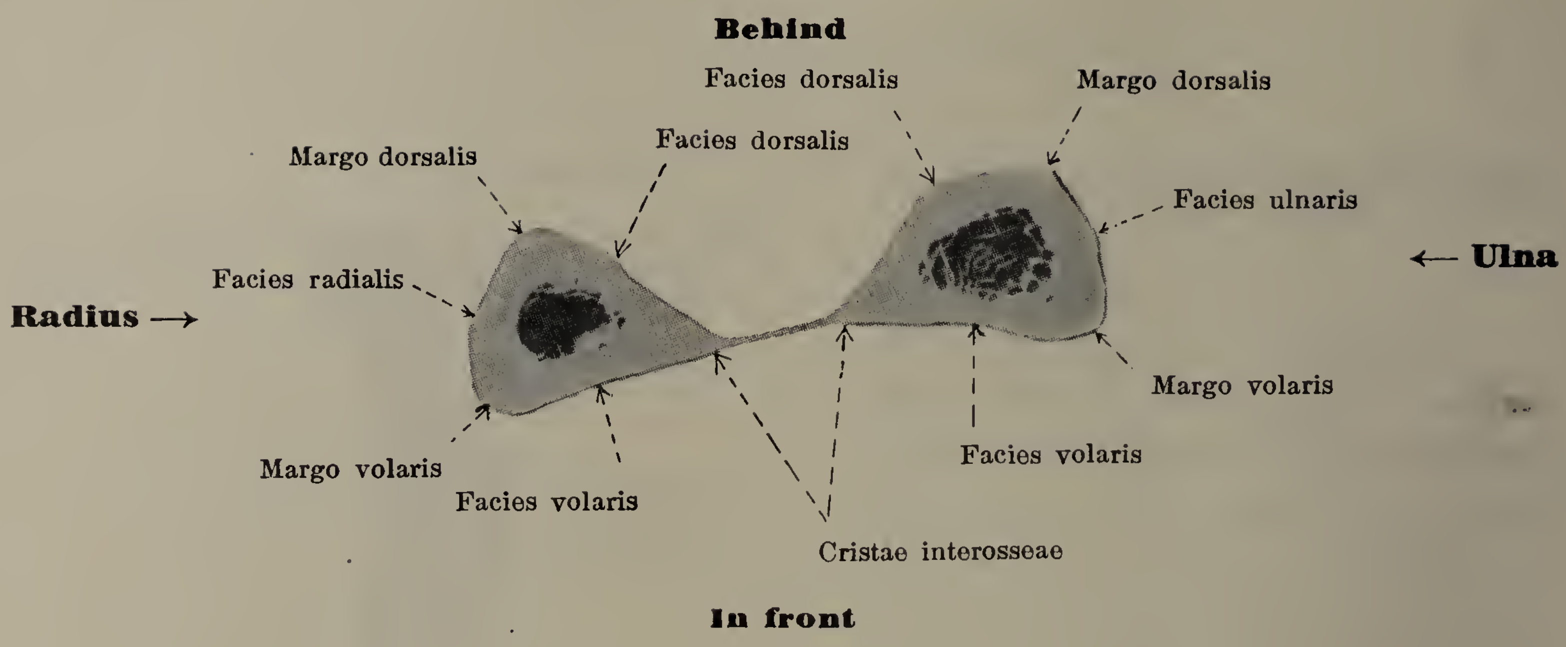
The ***corpus* radii** or shaft is bent so as to be somewhat convex toward the thumb side, usually somewhat curved dorsally and is triangularly prismatic. The narrowest of its three surfaces, *facies lateralis* (O. T. external surface) is directed toward the thumb side: it adjoins at the rounded *margo dorsalis* (O. T. posterior border) behind and the *margo volaris* (O. T. anterior border) in front, the broader *facies dorsalis* (O. T. posterior surface) and *facies volaris* (O. T. anterior surface). The ulnar angle formed by these two surfaces is especially sharp and is called the *crista interossea* (O. T. internal or interosseous border). A *foramen nutricium* is often visible at a spot corresponding to that on the ulna; the *canalis nutricius* is directed proximalward.

159. Right radius, *radius*, from behind.

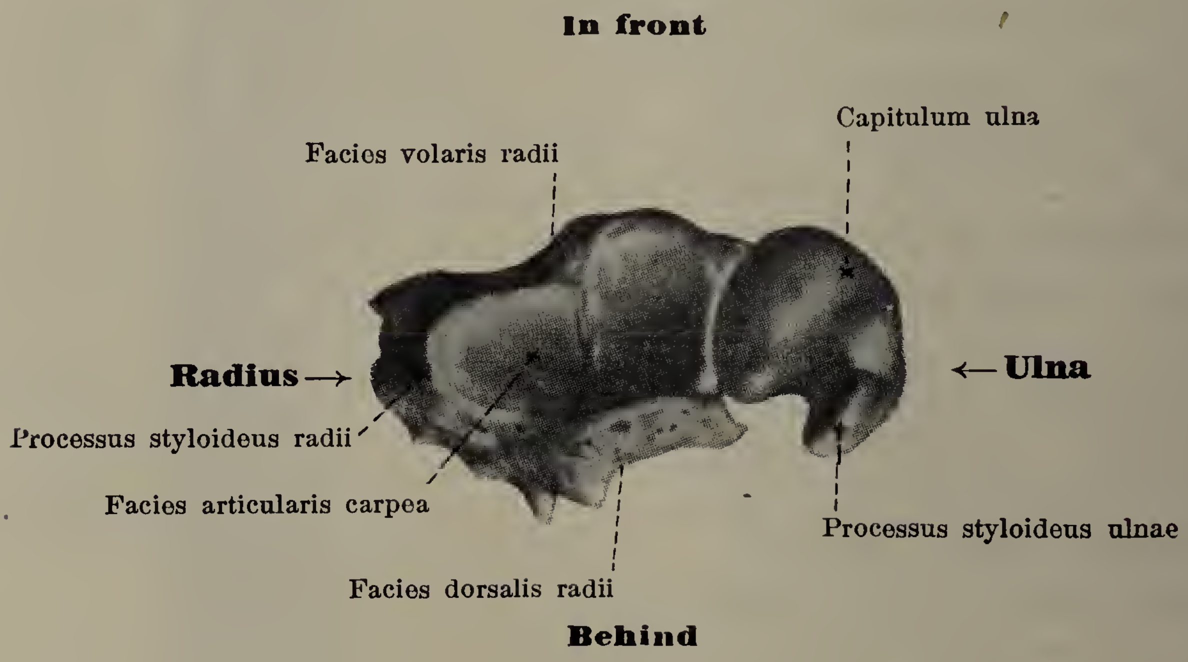
The ***upper extremity*** of the **radius** supports the button-shaped *capitulum radii (head)*; this is for the most part covered with cartilage and proximalward presents a small flat depression, *fovea capituli radii* (for articulation with the capitulum humeri); its circular periphery covered with cartilage, *circumferentia articularis*, moves in the incisura radialis ulnae. Just below the capitulum the bone is narrowed to form the neck, *collum radii*, and close below this spot, projecting ulnarward and volarward, is the *tuberositas radii* (O. T. bicipital tuberosity) (for the attachment of the m. biceps brachii).

The ***lower extremity*** is markedly broadened, quadrilateral. Its anterior surface is smooth and slightly concave; its posterior surface is subdivided by several longitudinal ridges into grooves for tendons (see Fig. 163). The distal terminal surface, *facies articularis carpea*, covered with cartilage, is slightly concave and triangular; it is subdivided, usually distinctly, into a triangular radial part (for the os naviculare) and a quadrangular ulnar part (for the radial portion of the os lunatum). On the ulnar side is a small notch covered with cartilage, the *incisura ulnaris* (O. T. sigmoid cavity) (for the capitulum ulnae and the discus articularis). Projecting distalward from the angle on the thumb side is the short, blunt, quadrilateral-conical *processus styloideus*.


Circumferentia articularis
Capitulum radii
Collum radii
Tuberositas radii
Foramen nutricium (Var.)
Crista interossea
Facies dorsalis
Margo dorsalis
Groove for the mm. extensores carpi radiales
Groove for the m. extensor pollicis longus
Incisura ulnaris
Groove for the m. extensor digitorum communis and extensor indicis
Processus styloideus



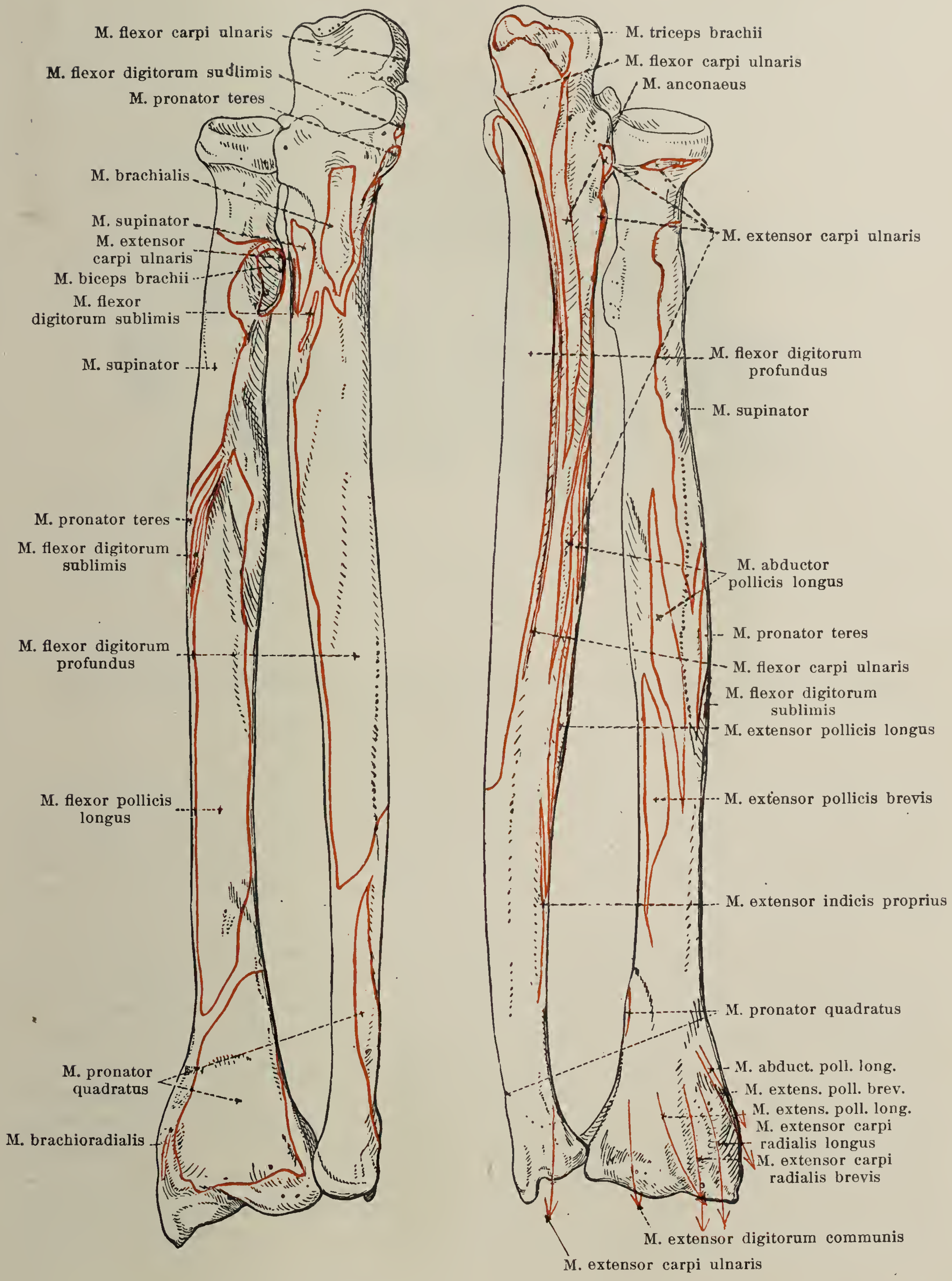
160. Transverse section through the middle of the bones of the right forearm, in supination, from above.



161. Lower extremity of the bones of the right forearm, in supination, from below.

The ***lower extremity*** of the **bones of the forearm** (see also Figs. 180 and 291) which forms the articulation with the carpus, presents on its distal surface the *facies articularis carpea radii* and the *capitulum ulnae.* The former articulates directly with the os naviculare manus and the radial part of the os lunatum. The capitulum ulnae on the contrary does not touch the ulnar part of the os lunatum and the os triquetrum, situated distalward from it, directly, but is separated from them by a discus articularis.

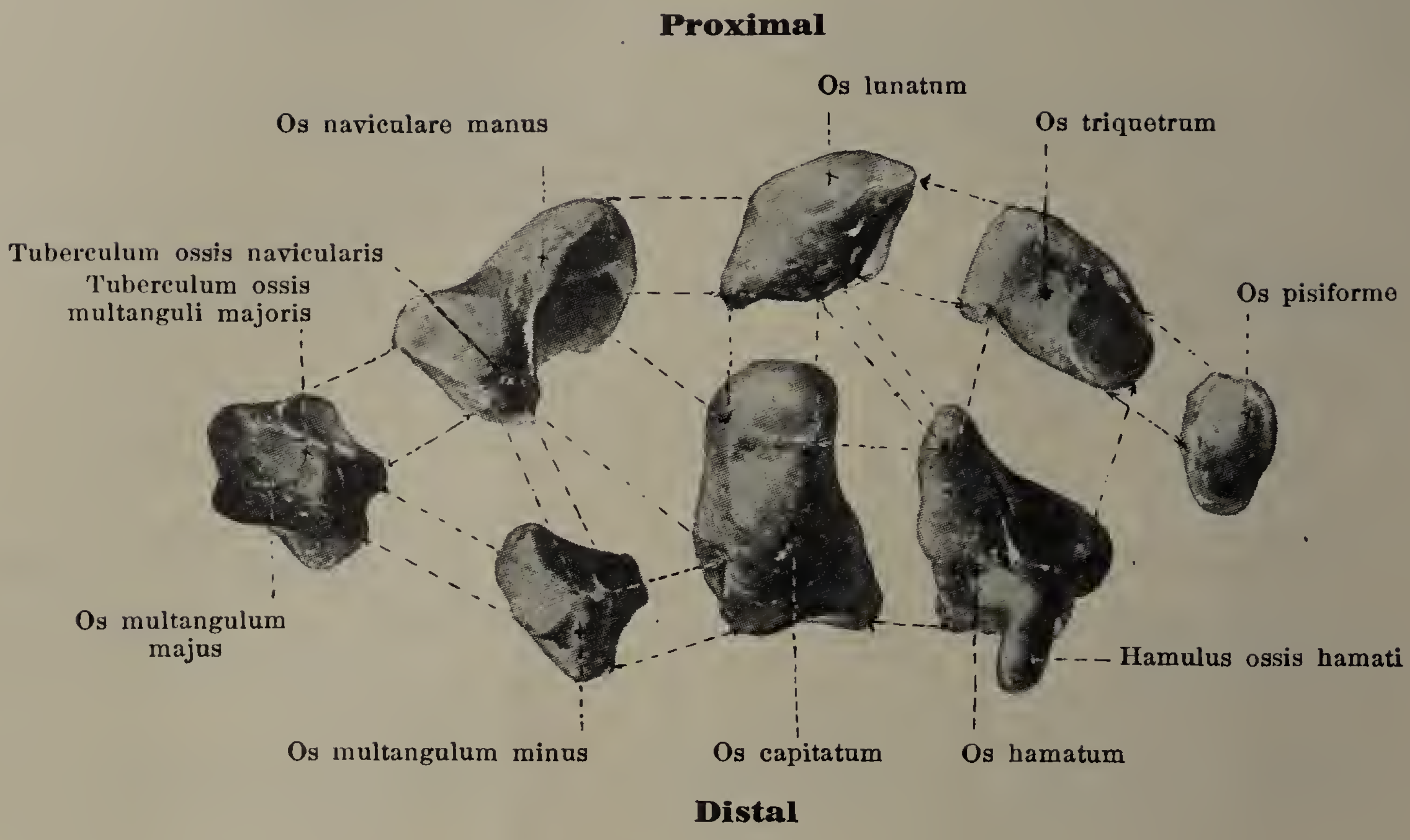
On the radial side of this surface the *processus styloideus radii* is visible, whilst the *processus styloideus ulnae* lies in supination at the dorsal edge of the *capitulum ulnae.*


M. flexor carpi ulnaris
M. flexor digitorum sublimis
M. pronator teres
M. brachialis
M. supinator
M. extensor carpi ulnaris
M. biceps brachii
M. flexor digitorum sublimis
M. supinator
M. pronator teres
M. flexor digitorum sublimis
M. flexor digitorum profundus
M. flexor pollicis longus
M. pronator quadratus
M. brachioradialis
M. triceps brachii
M. flexor carpi ulnaris
M. anconaeus
M. extensor carpi ulnaris
M. flexor digitorum profundus
M. supinator
M. abductor pollicis longus
M. pronator teres
M. flexor carpi ulnaris
M. flexor digitorum sublimis
M. extensor pollicis longus
M. extensor pollicis brevis
M. extensor indicis proprius
M. pronator quadratus
M. abduct. poll. long.
M. extens. poll. brev.
M. extens. poll. long.
M. extensor carpi radialis longus
M. extensor carpi radialis brevis
M. extensor digitorum communis
M. extensor carpi ulnaris

162 and 163. Bones of the right forearm,
in supination, with the muscular attachments,

from the surface corresponding the hollow of the hand.

from the side corresponding to the back of the hand.



164—171. Bones of the right carpus, *ossa carpi,*

shown singly, from the volar surface.

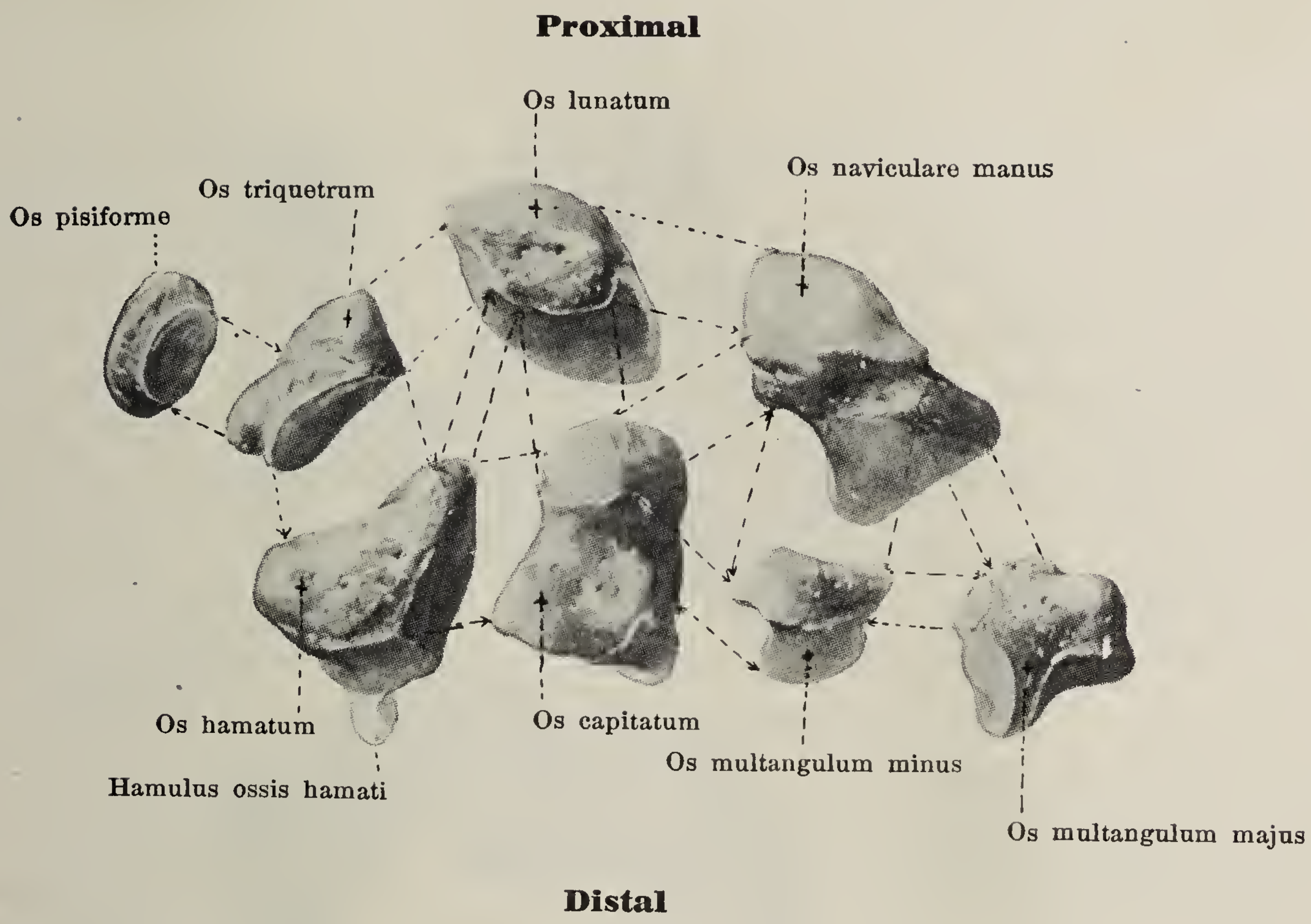
The eight **ossa carpi** *(wrist bones)* (see also Figs. 172—180, 182, 183 and 291) are arranged in two transverse rows of four each: the proximal (numbered from the thumb side) consists of the *os naviculare manus, os lunatum, os triquetrum, os pisiforme;* the distal of the *os multangulum majus, os multangulum minus, os capitatum, os hamatum.* (For the development see p. 127.)

The **os naviculare manus** (O. T. scaphoid bone) presents proximally a convex articular surface (for the radius), on its distal surface a convex articular surface (for the ossa multangula majus et minus), on the ulnar surface proximalward a small, crescent shaped, almost flat articular surface (for the os lunatum) and distalward a larger, concave surface (for the os capitatum). On the volar surface lies the *tuberculum ossis navicularis.*

The **os lunatum** (O. T. semilunar bone) presents proximally a markedly convex articular surface (for the radius and for the discus articularis of the joint formed by the forearm with the hand), distally a markedly concave articular surface (for the os capitatum) and a narrow, slightly concave one (for the os hamatum); radialward lies a small, crescent shaped, almost flat articular surface for the os naviculare, ulnarward a small, square, flat articular surface for the os triquetrum. The volar surface is square, and somewhat larger than the dorsal.

The **os triquetrum** (O. T. cuneiform bone) has proximally a small, convex articular surface (it is sometimes missed) (for the discus articularis of the joint formed by the forearm with the hand), distally a large surface curved like the thread of a screw (for the os hamatum) radialward a small flat one (for the os lunatum) and on the volar surface a small, flat, rounded articular surface (for the os pisiforme).

The **os pisiforme** is a small, egg-shaped bone which dorsalward presents a small, flat rounded articular surface (for the os triquetrum).



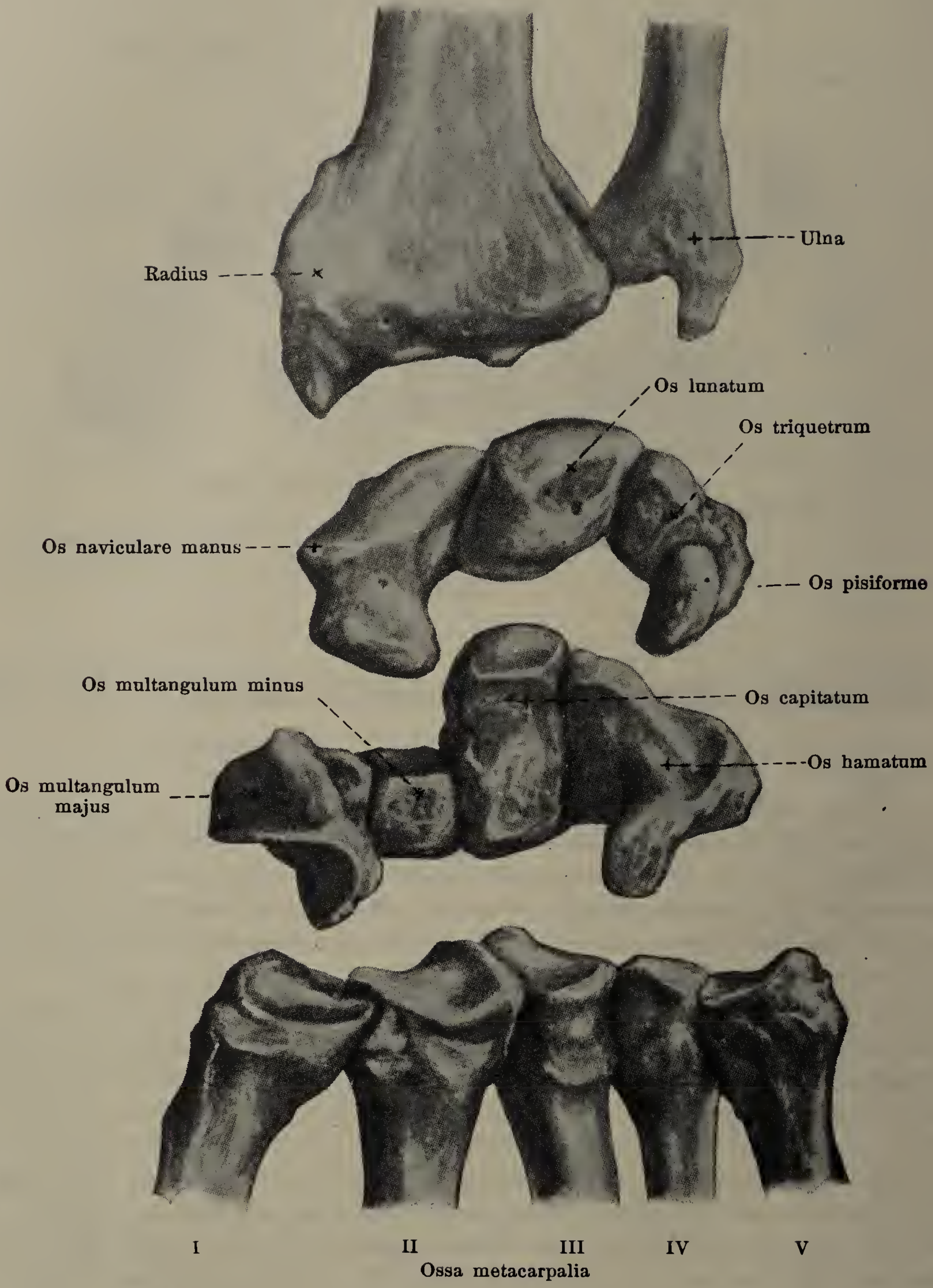
172—179. Bones of the right carpus, *ossa carpi,*
shown singly, from the dorsal surface.

The **os multangulum majus** or *large multangular bone* (O. T. trapezium) has proximally a slightly concave articular surface (for the os naviculare), distalward a saddle-shaped surface (for the os metacarpale I), ulnarward a proximal somewhat larger, slightly concave surface (for the os multangulum minus) and a small distal surface (for the os metacarpale II). On the volar surface is a small projection, ***tuberculum ossi multanguli majoris,*** and ulnarward from it a groove (for the tendon of the m. flexor carpi radialis).

The **os multangulum minus** or *small multangular bone* (O. T. trapezoid bone) presents proximally a slightly concave articular surface (for the os naviculare), distalward a flat saddle-shaped surface (for the os metacarpale II); on the radial surface lies a slightly convex articular surface (for the os multangulum majus), on the ulnar a feebly concave surface (for the os capitatum). The dorsal surface is rough and distinctly larger than the volar one.

The **os capitatum** (O. T. os magnum) is inserted in its proximal part ***(caput, head)*** into the deep concavity formed by the os naviculare and the os lunatum. It supports there a markedly convex articular surface (for the os lunatum), distalward a tripartite, almost flat, articular surface (for the ossa metacarpalia II, III, IV); radialward are convex articular surfaces for the os naviculare and the os multangulum minus, ulnarward a flat articular sometimes divided surface for the os hamatum. The volar surface is narrower than the dorsal, and shows a long, rough projection.

The **os hamatum** or *hook bone* (O. T. unciform bone) presents a large, articular surface, curved like the thread of a screw (for the os lunatum and the os triquetrum) directed proximally and at the same time ulnarward; distally is a double nearly flat articular surface (for the ossa metacarpalia IV, V) and radialward a single, flat, sometimes divided articular surface (for the os capitatum). On the volar surface a flat somewhat curved process projects upward radially, the ***hamulus ossis hamati*** (O. T. cuneiform process).

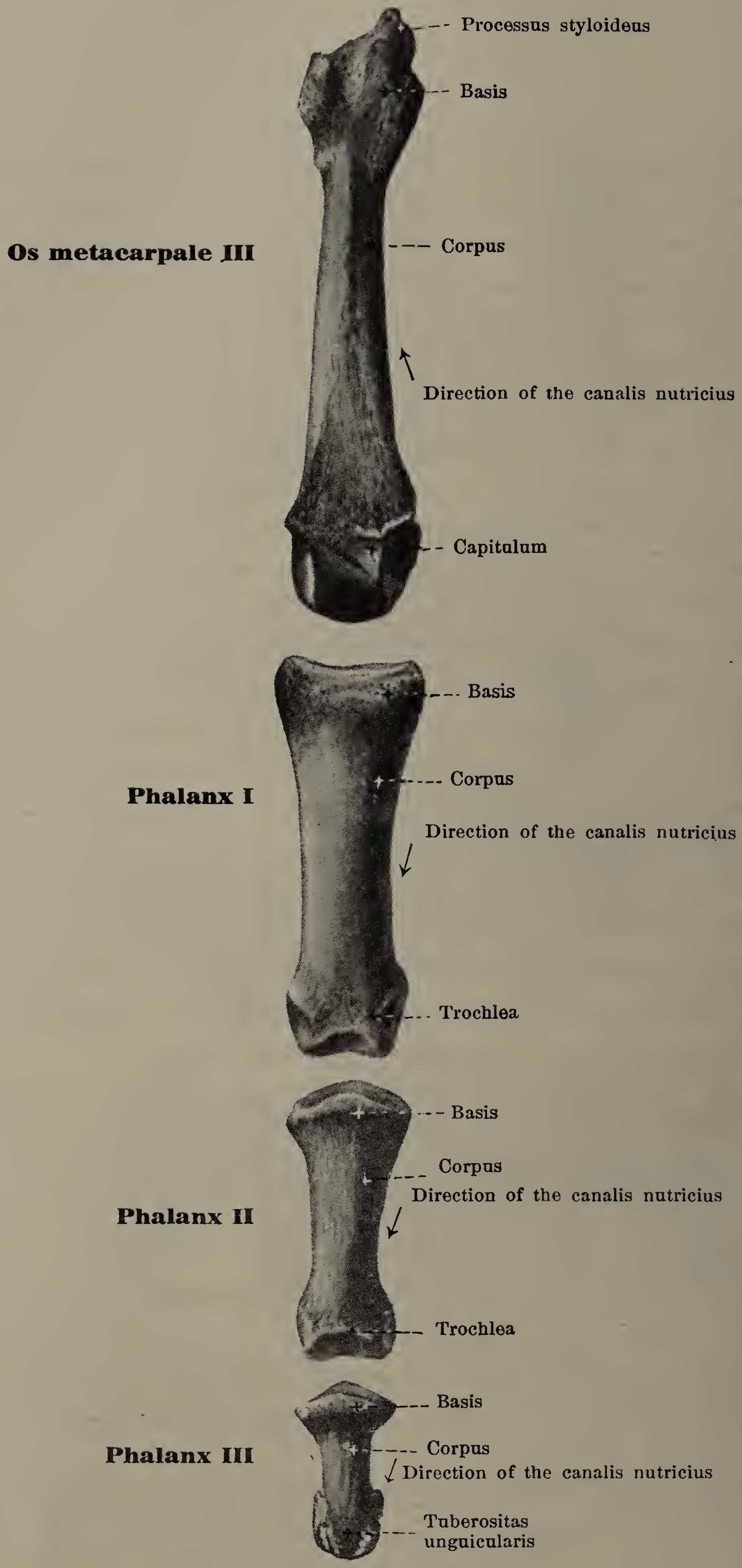


180. Right wrist and neighboring bones,
in transverse rows, separated from one another, from the volar surface.
(Radius and ulna are in supination.)

The **first carpal row** (see also Fig. 291), considered as a whole, has proximalward an elongated oval, markedly convex, articular surface, in the formation of which participate the os naviculare and the os lunatum especially, the os triquetrum to a less extent; the os naviculare and the radial part of the os lunatum articulate with the facies articularis carpea radii, the ulnar part of the os lunatum and the os triquetrum with the discus articularis situated below the capitulum ulnae. The os pisiforme takes no part in the articulation with the bones of the forearm nor in that with the second carpal row, but is simply attached to the volar surface of the os triquetrum. Distalward the first carpal row is bounded by a surface, the radial portion of which (formed by the os naviculare) is convex, distinctly bent and projects markedly distalward, and its ulnar portion (formed by the ossa naviculare, lunatum, triquetrum) represents a markedly hollowed out depression.

The **second carpal row** (see also Fig. 291) ends proximalward in a distinctly bent surface, the radial portion of which (formed by the ossa multangula majus et minus) is concave and its ulnar part (formed by the os capitatum and os hamatum) represents a head projecting markedly proximalward. These proximal surfaces are approximately impressions of the corresponding distal surfaces of the first carpal row. The distal boundary of the second row is formed by a wavy surface in which the ossa metacarpalia are deposited; furthest radialward lies the saddle-shaped surface for the os metacarpale I (formed by the os multangulum majus); after this comes the surface for the os metacarpale II (formed chiefly by the os multangulum minus and partly by the os multangulum majus and the os capitatum); then the surface for the os metacarpale III (formed by the os capitatum), then the surface for the os metacarpale IV (formed chiefly by the os hamatum and partly by the os capitatum) and finally the surface for the os metacarpale V (formed by the os hamatum).

The **carpus** *(wrist)* (see Figs. 182 and 183) is on the whole almost quadrangular, and narrower proximally than distally. It is besides curved so as to be somewhat convex dorsalward and, accordingly, volarward forms a groove which is made deeper by the fact that the radial and the ulnar sides are somewhat elevated; radialward are the tuberculum ossis navicularis and the tuberculum ossis multanguli majoris which together form the ***eminentia carpi radialis;*** ulnarward the os pisiforme and the hamulus ossis hamati project upward and form the ***eminentia carpi ulnaris.*** The groove bounded by the two eminentiae carpi is called the ***sulcus carpi;*** it is converted into a complete ***canalis carpi*** by the ligamentum carpi transversum which extends between the eminentiae; through this canal go tendons, vessels and nerves to and from the fingers.



181. Metacarpal bone and phalanges of the third finger of the right hand, *os metacarpale III et phalanges digiti III,* from the dorsal surface.

The five **ossa metacarpalia** (see also Figs. 180, 182—185) are short cylindrical bones, each of which is divisible into a shaft, or *corpus*, a proximal extremity, *basis*, and a distal extremity, *capitulum*. The whole bone is curved, so as to be slightly convex toward the back of the hand. (For the development see p. 127.)

The *corpus* or *shaft* is trilateral so that one side looks dorsalward, the other two radial- and ulnarward; the latter surfaces meet in an edge directed volarward. On the volar surface is a large *foramen nutricium*, which leads into a *canalis nutricius* directed in the thumb distalward, in the second to the fifth finger proximalward.

The *basis* (see also Fig. 291) is somewhat broadened and presents on its proximal surface an articular surface for connection with the carpus, between the second and the fifth finger also small articular surfaces on the radial and ulnar surfaces for the neighboring metacarpal bones. The basis ossis metacarpalis I (see Fig. 180), has a proximal saddle shaped-joint surface (for the os multangulum majus) but no lateral articular surfaces. The proximal articular surface of the basis ossis metacarpalis II is divided into three unequal parts (see Fig. 180 and p. 119) and the one of the basis ossis metacarpalis IV into two unequal parts. On the basis ossis metacarpalis III, from the radial part of the dorsal surface, a blunt process, the *processus styloideus ossis metacarpalis III* (insertion of the m. extensor carpi radialis brevis), projects toward the carpus. The basis ossis metacarpalis V (see Fig. 180) presents proximalward a slightly saddle-shaped articular surface for the os hamatum and a flat articular surface on the radial side.

Each *capitulum* possesses a spherical articular surface, covered with cartilage, which extends upon the volar more than upon the dorsal surface. On the two sides there are depressions and roughened areas for the ligaments of the joint.

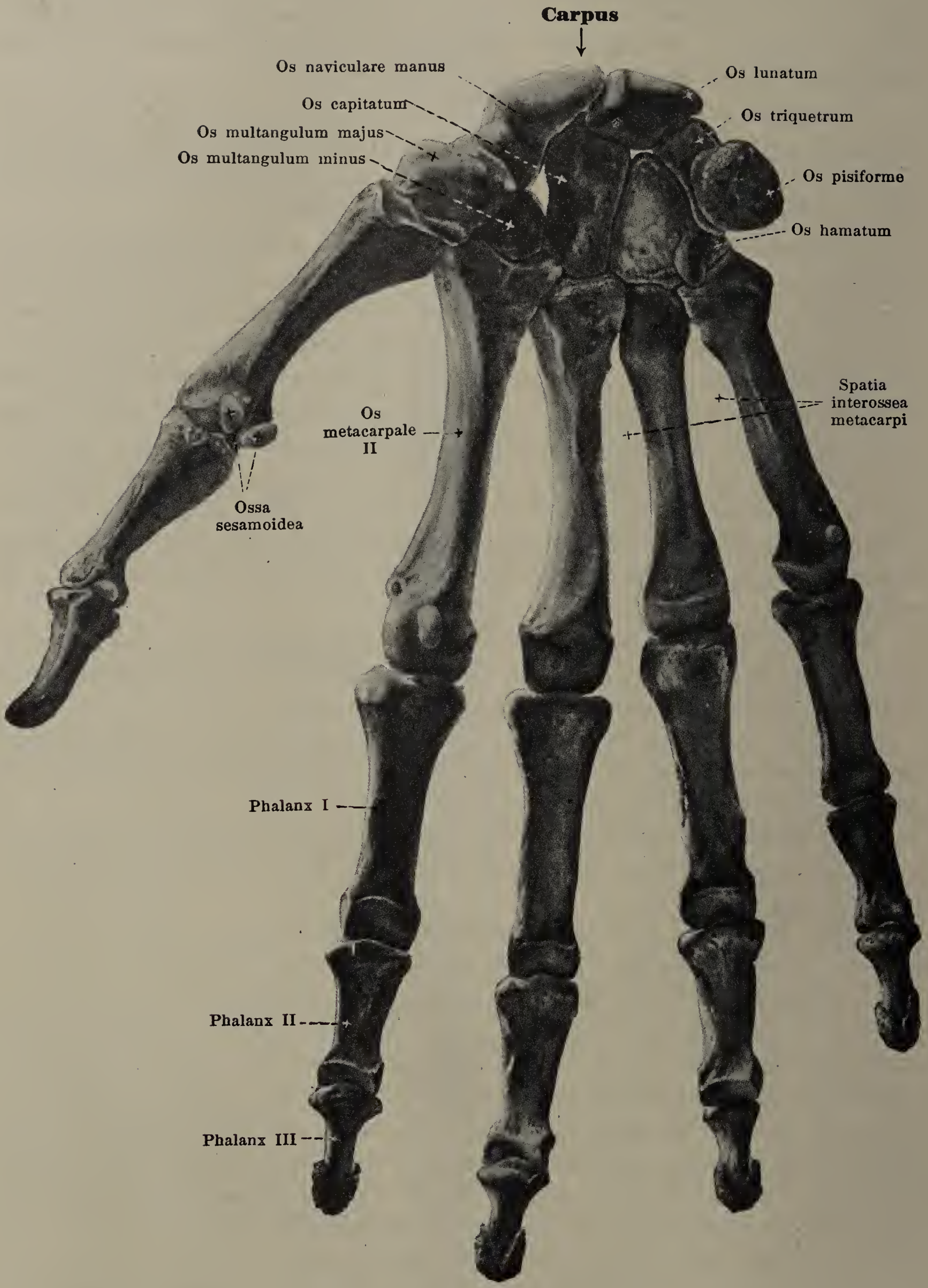
The four spaces lying between the ossa metacarpalia (see Figs. 182 and 183) are called *spatia interossea metacarpi*. The first, between thumb and index finger is the broadest. They are all filled out by the mm. interossei.

The **phalanges digitorum** (see also Figs. 182 and 183) are three in number from the second to the fifth finger; while on the thumb there are two; they are called *phalanx prima, secunda, tertia.*

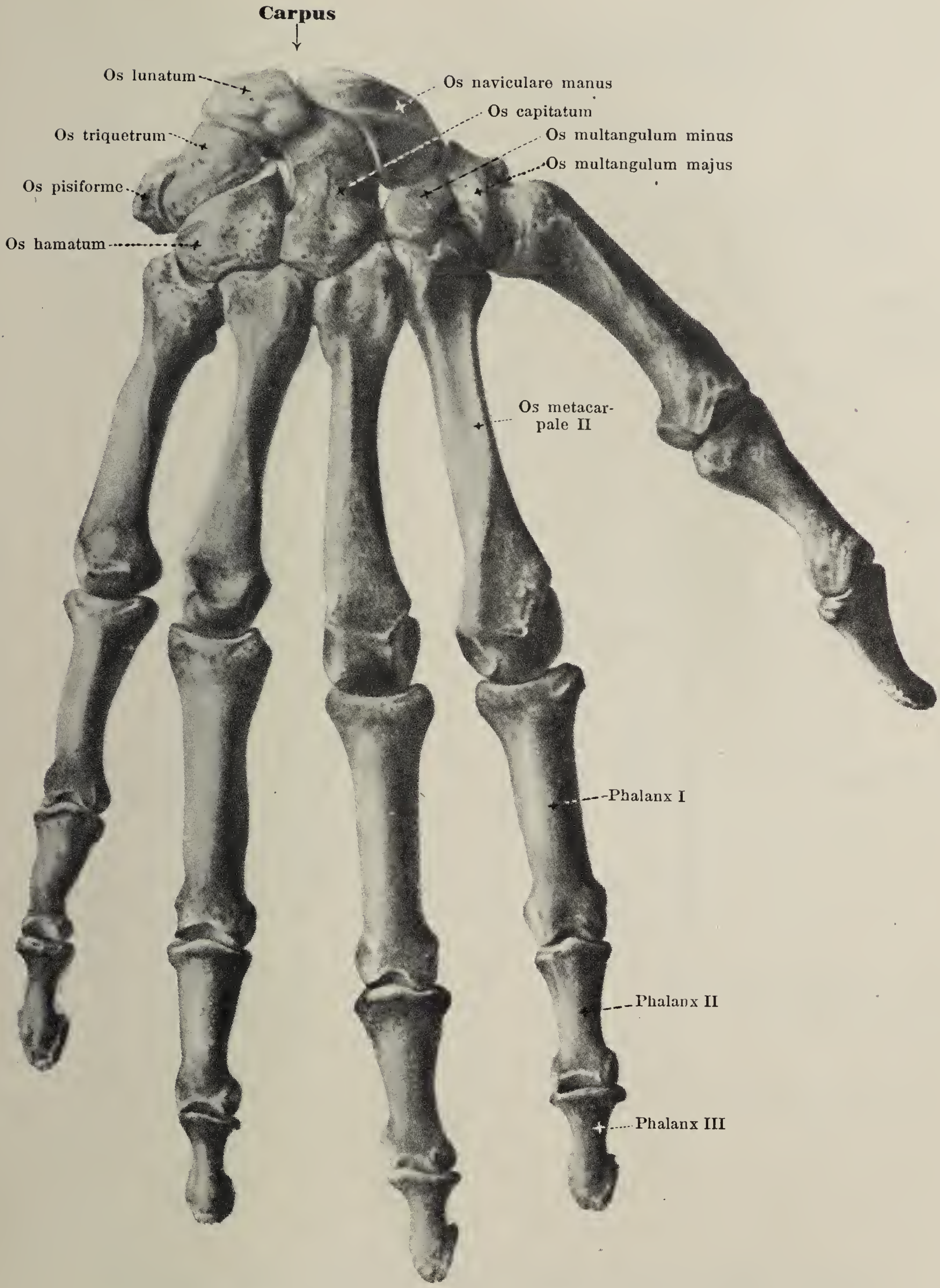
Each *phalanx* is a short cylindrical bone which is divisible into a shaft or *corpus*, a proximal end, *basis*, and a distal end. (For the development see p. 127.)

The *corpus* is flat volarward and curved dorsalward so as to be convex in transverse direction. A large *foramen nutricium* on its volar surface leads into a *canalis nutricius* directed distalward. The *basis* is somewhat broadened and possesses a deep articular surface, covered with cartilage, which on the first phalanx is simple, on the others is divided by a blunt ridge. The distal end of the first phalanx of the thumb and also of the first and second phalanx of the remaining fingers has a *trochlea*, a small transverse roller surface, covered with cartilage, with a smooth groove in the middle; on the sides lie small depressions for the attachment of the ligaments of the joint. On the terminal phalanx the distal end is transformed to a broad flat rough area, the *tuberositas unguicularis.*

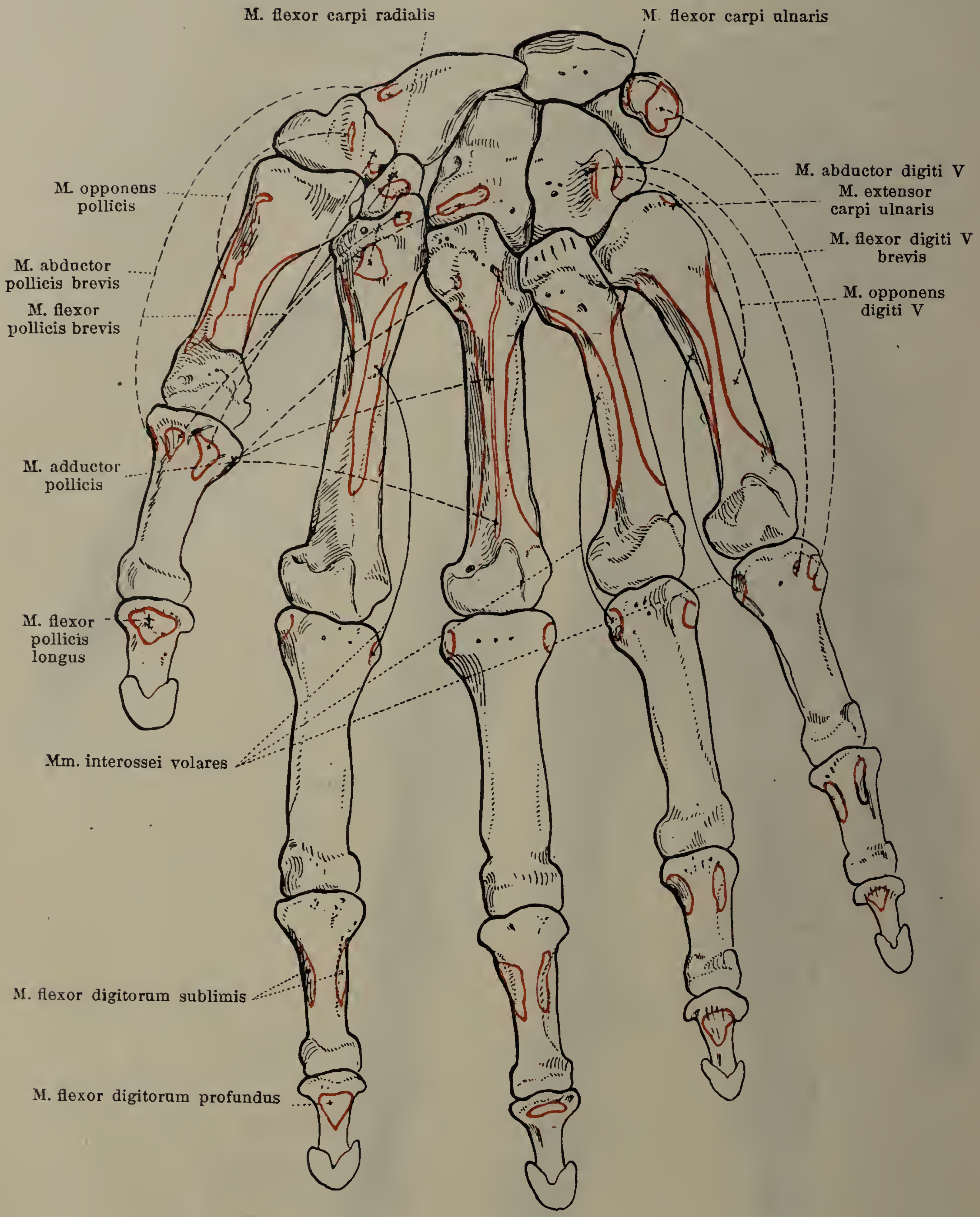
Ossa sesamoidea *(sesamoid bones)* (see Fig. 182) are small masses of bone which embedded in tendons or ligaments, lie upon the other bones. There are constantly or almost constantly five such on the volar surface, two at the metacarpophalangeal joint of the thumb, one at the interphalangeal joint of the thumb and one each at the metacarpophalangeal joint of the second and of the fifth finger. (For the development see p. 127.)



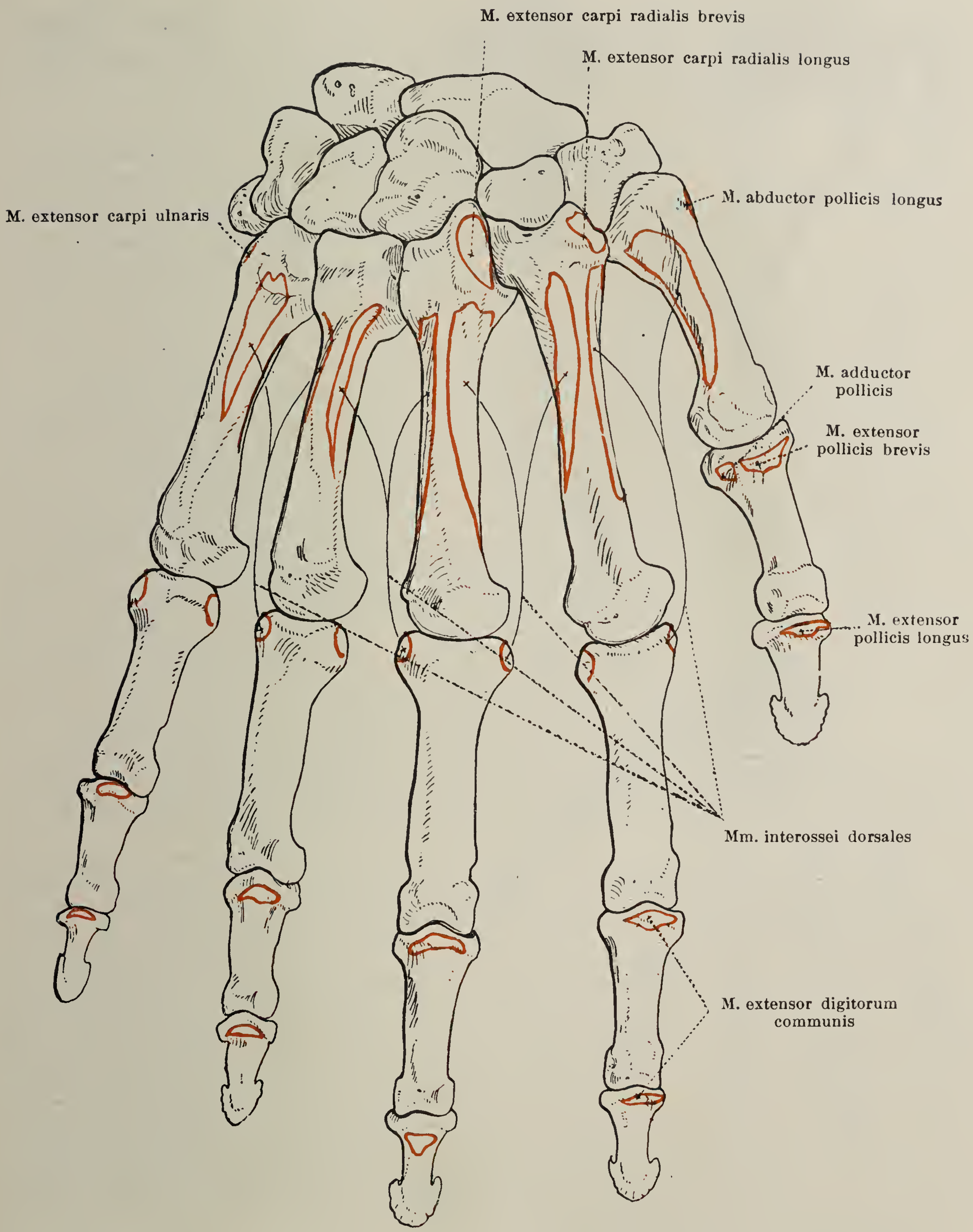
182. Bones of the right hand, *ossa manus,* from the volar surface.



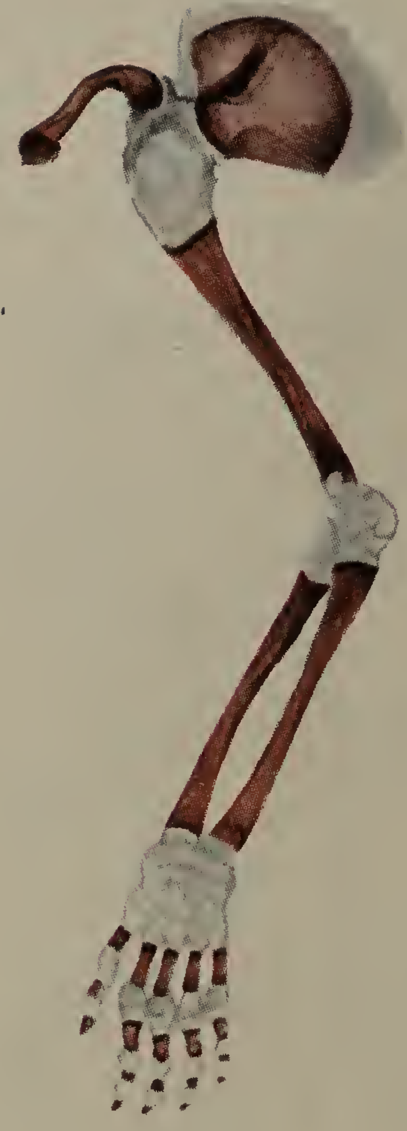
183. Bones of the right hand, *ossa manus,* from the dorsal surface.


M. flexor carpi radialis
M. flexor carpi ulnaris
M. opponens pollicis
M. abductor digiti V
M. extensor carpi ulnaris
M. abductor pollicis brevis
M. flexor digiti V brevis
M. flexor pollicis brevis
M. opponens digiti V
M. adductor pollicis
M. flexor pollicis longus
Mm. interossei volares
M. flexor digitorum sublimis
M. flexor digitorum profundus

184. Bones of the right hand, *ossa manus,*
from the volar surface, with the muscular attachments.


M. extensor carpi radialis brevis
M. extensor carpi radialis longus
M. abductor pollicis longus
M. extensor carpi ulnaris
M. adductor pollicis
M. extensor pollicis brevis
M. extensor pollicis longus
Mm. interossei dorsales
M. extensor digitorum communis

185. **Bones of the right hand,** *ossa manus,* from the dorsal surface, with the muscular attachments.



186. Skeleton of the right upper extremity of a fetus 5 months old,

from in front. Magnif.: 1 : 1.

(The bone substance is colored red, the rest is made transparent.)

Development of the bones of the upper extremity. They are all preformed in cartilage. The clavicle is an exception in so far as its primitive centre of development appears prior to the formation of any cartilaginous matrix; the further development, however, takes place in this bone like in all the others from cartilage.

Scapula. The main centre or nucleus appears in the 8th week near the lateral angle and forms the body, the spine, and base of the glenoid cavity. In the first year of life; there appears a nucleus in the proc. coracoideus, which at puberty fuses with the main mass, and in the 10th—12th year there develops a *subcoracoid* nucleus in the basis of the proc. coracoideus and at the upper edge of the cavitas glenoidalis, which fuses with the main mass about the 18th year. Besides these there appear the following epiphyses: 1. in the acromion (2—3 which quickly fuse) in the 15th—18th year (fusion with the spina in the 20th year); 2. in the superior lateral part of the proc. coracoideus in the 16th—18th year; 3. in the surface of the cavitas glenoidalis in the 16th—18th year; 4. on the angulus inferior in the 16th—18th year and 5. on the margo vertebralis in the 18th—20th year. In the 18th—24th year there begins a union with the main mass of bone first of the epiphyses of the proc. coracoideus, then of those of the cavitas glenoidalis, then of the angulus inferior, and lastly of the margo vertebralis.

Clavicula. The shaft shows at the end of the 6th week (before all other bone nuclei in the body!) a medial and a lateral nucleus which soon unite. At the sternal end there appears an epiphysis in the 18th—20th year, which unites with the shaft in the 20th—25th year.

Humerus (see also Fig. 187). The nucleus for the shaft first appears in the 6th to 7th week. At the proximal end there develops an epiphyseal nucleus for the caput in the 1st to 2nd year (sometimes before birth), one for the tuberculum majus in the 1st to 3rd year, ond one for the tuberculum minus (not constant) in the 3rd—5th year; these coalesce in the 4th to 6th year, and unite with the shaft in the 16th—25th year. At the distal end there appear epiphyseal nuclei in the capitulum in the 1st—3rd year, in the epicondylus medialis in the 5th to 9th year, in the trochlea (serrated) in the 8th—16th year, and in the epicondylus lateralis in the 11th—18th year; of these the three lateral ones first unite with each other and then (in the 16th—17th year) with the shaft, while the epiphyses of the epicondylus medialis unites with the shaft in the 18th year.

Ulna (see also Fig. 188). The nucleus for the shaft appears in the 7th week, a few days later than the radius. In the distal epiphysis a nucleus is formed in the 6th—9th year (union in the 18th—24th year), and in the proximal epiphysis (in the olecranon) in the 8th to 14th year (union in the 17th year).

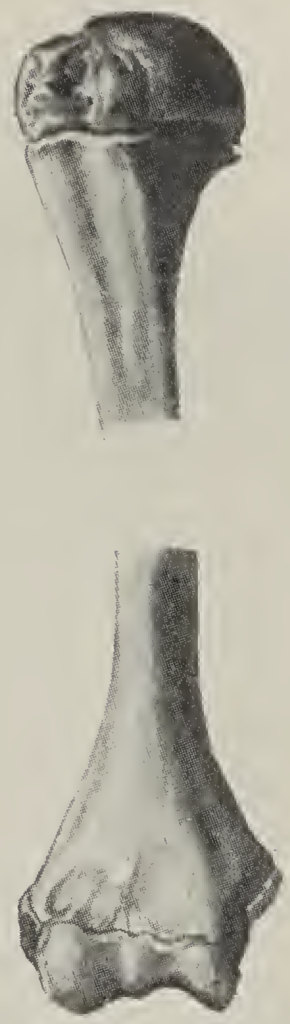
Radius (see also Fig. 189). The nucleus of the shaft appears in the 7th week. A nucleus in the distal epiphysis appears between the 8th embryonal month and the 3rd year; this unites with the shaft in the 21st—25th year. In the proximal epiphysis a nucleus first develops between the 4th and 9th year, and unites with the shaft in the 17th—20th year. An epiphysis sometimes appears in the tuberositas radii and in the processus styloideus.

Carpus (see also Fig. 186). A nucleus appears in the os capitatum and the os hamatum in the 1st year; in the os triquetrum in the 2nd—3rd year, in the os lunatum in the 3rd—5th year, in the os naviculare, os multangulum majus and os multangulum minus in the 4th—6th year and in the os pisiforme in the 9th—13th year. In some bones there may occur two nuclei or centres of ossification.

Ossa metacarpalia (see also Fig. 186). Each os metacarpale receives a nucleus for its shaft in the 9th week (in the order of II, III, IV, V, I); besides these there is formed an epiphysis for the os metacarpale II—V at the distal end in the 2nd—3rd year, and for the os metacarpale I at the proximal end in the 3rd year. The epiphyses unite with the shafts in the 15th to 20th year.

Phalanges (see also Fig. 186). In the 1st row there appear nuclei for the diaphyses in the 9th week and for the proximal epiphyses in the 1st—3rd year; in the 2nd row nuclei for the diaphyses appear in the 11th—12th week and nuclei for the proximal epiphyses in the 2nd to 3rd year; in the 3rd row nuclei for the diaphyses in the 7th—8th week and nuclei for the proximal epiphyses in the 2nd—3rd year. So that in the hand, the nuclei or centres of ossification for the end phalanges appear first, then those for the ossa metacarpalia, then those for the first row of phalanges and lastly the centres for the second row of phalanges. The union of the epiphyses and diaphyses occurs between the 18th and 20th year.

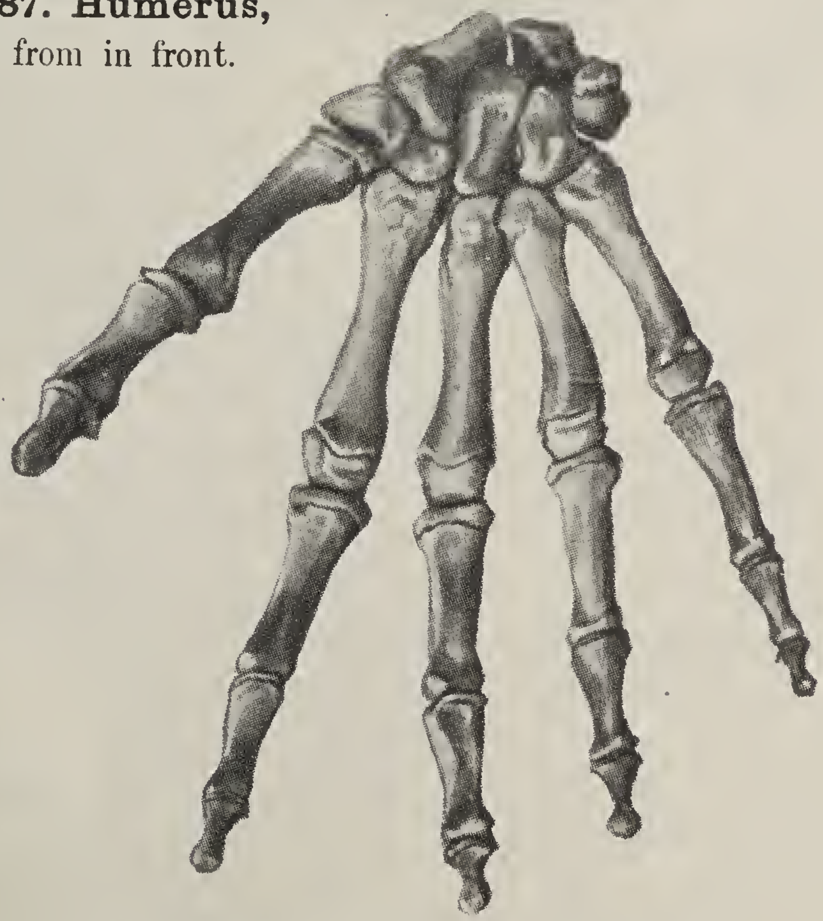
Ossa sesamoidea. These ossify usually between the 13th and 14th year; sometimes, however, later.



187. Humerus, from in front.

188. Ulna, from inner side.

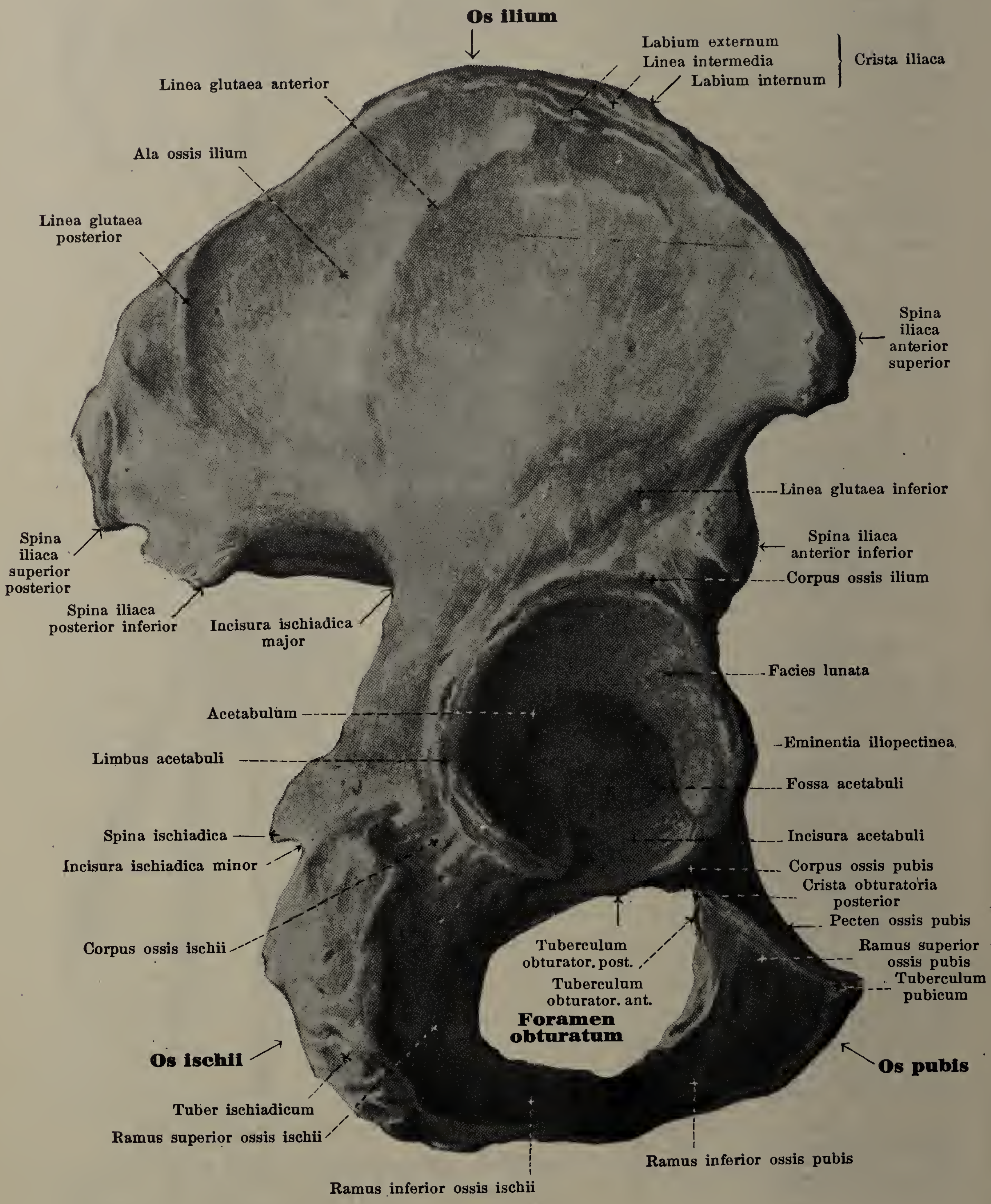
189. Radius, from in front.



190. Hand, from the volar surface.

187—190. Bones of the right upper extremity of a 10 years old girl. Magnification: 1 : 2.

(Of the long bones in each case only the proximal and distal ends are drawn.)

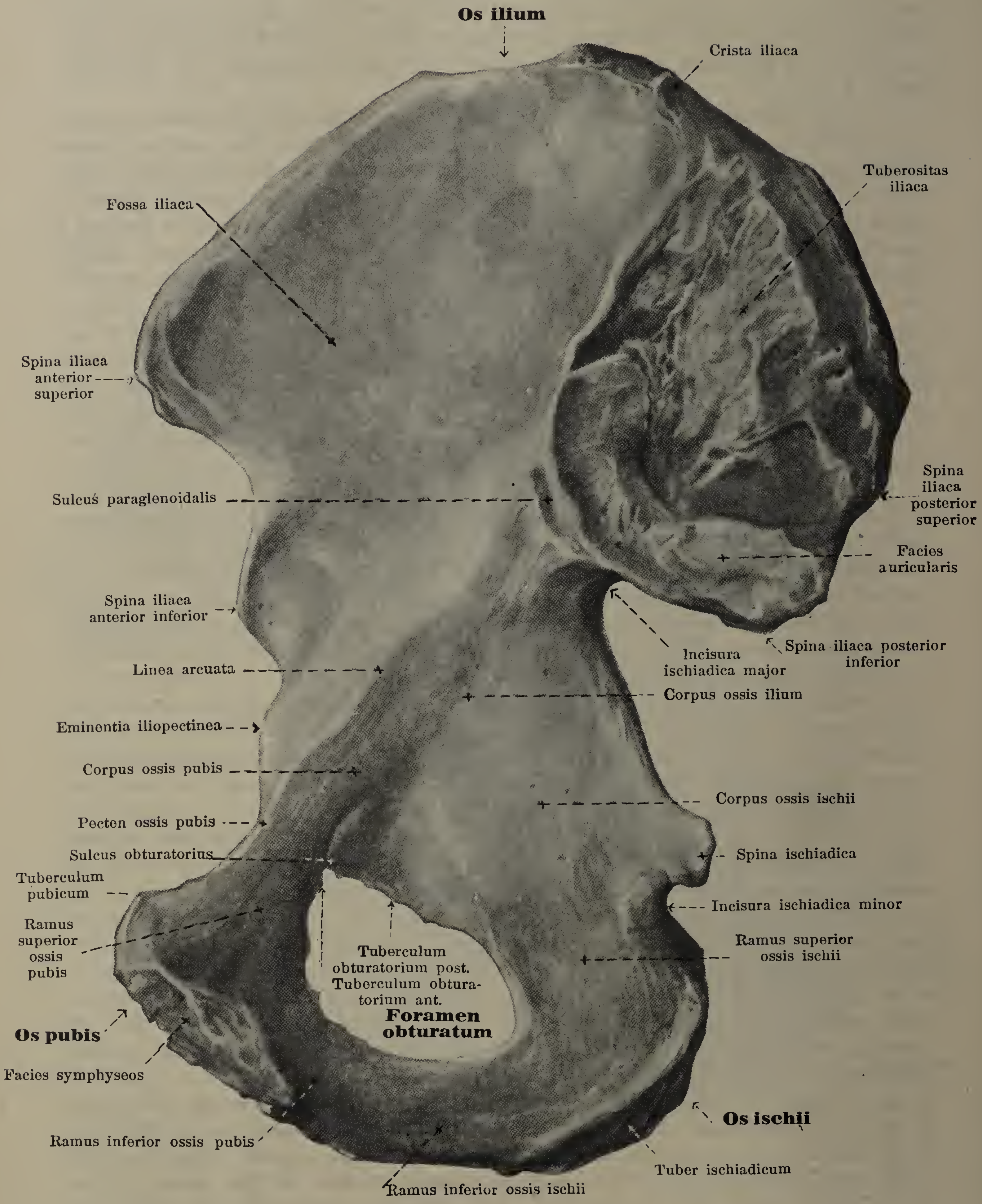


191. **Right hip bone,** *os coxae,* from without.

The **os coxae** *(hip bone)* (O. T. os innominatum) (see also Figs. 192—206) is paired, lies in the lowermost part of the trunk, and forms there with the same bone of the other side and with the sacrum a firm broad bony ring, the *pelvis*, upon which the vertebral column rests above and with which, externally, the bones of the thigh are connected. (For the development see p. 166.)

Each os coxae is composed of three pieces, which are distinctly separated from each other in the middle by a cartilaginous layer until the age of puberty, the *os ilium* which is directed upward and backward, the *os ischii* which is directed downward and backward and the *os pubis* which is directed forward and downward. These three constituents meet somewhat below the middle of the hip bone. This place and its surroundings form on the medial side of the bone a smooth surface. On the external surface lies a wide deep fossa, the *acetabulum*. This is surrounded by a high bony wall which terminates in a somewhat blunt edge, *limbus acetabuli*, and presents below a broad notch, the *incisura acetabuli;* in the bottom of the acetabulum a large rough spot is visible, the *fossa acetabuli*, which is surrounded in front, above and behind by a horse-shoe-shaped concave surface, the *facies lunata*, covered with cartilage. The acetabulum serves for articulation with the femur. In youth the places where the three bones unite are visible as a Y-shaped seam, the middle point of which is situated in the fossa acetabuli. The part of each of the three bone components which helps to form the hollow and its immediate vicinity is called the *corpus*.

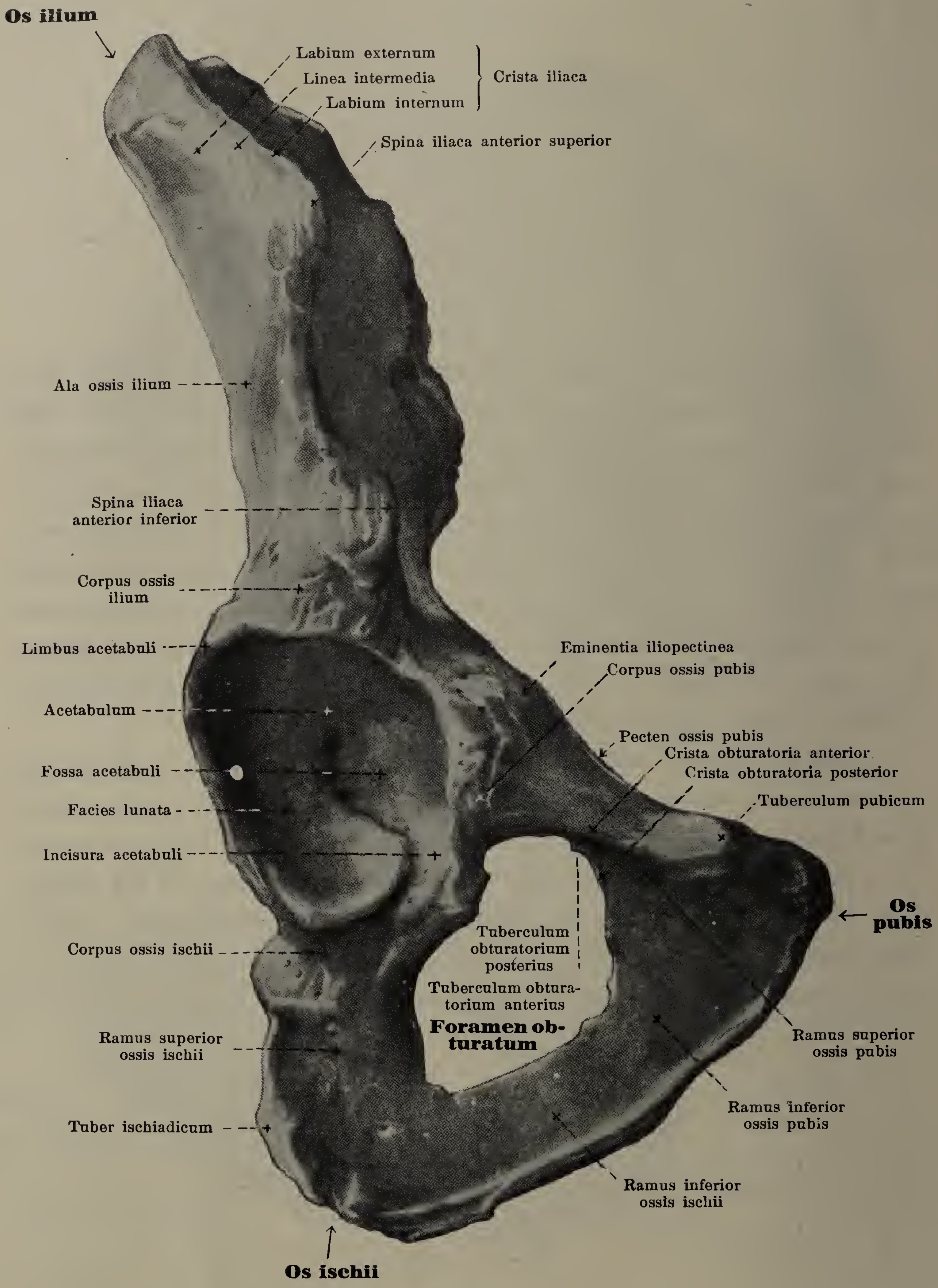
The ***os ilium*** (see also Figs. 192—194 and 196—206) helps to form the acetabulum by means of its thick and broad lower part, the *corpus ossis ilium* (vide supra); the upper part is a broad, in places very thin, somewhat wavy bony plate which bends backward, upward and lateralward and is called the *ala ossis ilium*. The corpus and ala are separated from one another by the *linea arcuata*, curved rounded bony ridge descending on the medial side obliquely from behind and above, forward and downward. The free margin of the ala ossis ilium is curved like the letter S, being concave medianward in front and convex medianward behind; elsewhere it is markedly broadened; it is called the *crista iliaca (iliac crest)*. On it the places of attachment of the abdominal muscles are marked as ridges, namely as *labium externum* and *labium internum* on the external and internal angle of the crest and as *linea intermedia* between these two. The crest ends in front in a blunt projection, *spina iliaca anterior superior;* below this the margin is narrower, somewhat concave and presents a second less marked projection, *spina iliaca anterior inferior;* below this it goes over into the corpus ossis pubis and there forms with the latter a flat roll, the *eminentia iliopectinea*. The iliac crest ends behind at the *spina iliaca posterior superior;* below it, separated by a small notch, lies the *spina iliaca posterior inferior* (sometimes indistinct), and still lower is a deep notch involving also the corpus ossis ischii, the *incisura ischiadica major* (O. T. great sacro-sciatic notch) (see also p. 131). The medial surface of the ala is, for the most part, smooth, slightly concave, the *fossa iliaca*, at the lowest part of which the bone is greatly thinned; behind it is an uneven surface, the anterior irregularly-triangular portion of which, *facies auricularis*, covered with cartilage, articulates with the facies auricularis ossis sacri, while its posterior, very rough portion, *tuberositas iliaca*, serves chiefly for the attachment of the ligamenta sacroiliaca interossea. The facies auricularis is not infrequently partially surrounded in front and behind by a groove, the *sulcus paraglenoidalis*, which serves for the attachment of the deep fibrous bands of the ligamenta sacroiliaca. The external surface of the ala is fairly smooth, and curved so as to be convex in front, concave behind. It presents three rough ridges, convex upward and backward, the shortest of which, the *linea glutaea inferior* (O. T. inferior curved line), lies just above the acetabulum; above and behind this is the *linea glutaea anterior* (O. T. middle curved line) which is the longest of the ridges and extends from the incisura ischiadica major to the spina iliaca anterior superior; above this the shorter *linea glutaea posterior* (O. T. superior curved line) runs from the spina iliaca posterior inferior to the crista iliaca.


Os ilium
Crista iliaca
Tuberositas iliaca
Fossa iliaca
Spina iliaca anterior superior
Spina iliaca posterior superior
Sulcus paraglenoidalis
Facies auricularis
Spina iliaca anterior inferior
Incisura ischiadica major
Spina iliaca posterior inferior
Linea arcuata
Corpus ossis ilium
Eminentia iliopectinea
Corpus ossis pubis
Corpus ossis ischii
Pecten ossis pubis
Sulcus obturatorius
Spina ischiadica
Tuberculum pubicum
Incisura ischiadica minor
Ramus superior ossis pubis
Ramus superior ossis ischii
Tuberculum obturatorium post.
Tuberculum obturatorium ant.
Foramen obturatum
Os pubis
Facies symphyseos
Os ischii
Ramus inferior ossis pubis
Tuber ischiadicum
Ramus inferior ossis ischii

192. Right hip bone, *os coxae*, from within.

The ***os ischii*** (O. T. ischium) (see also Figs. 191 and 193—206) helps by its thicker upper part or *body,* the *corpus ossis ischii,* to form the acetabulum (see p. 129). At the anterior margin of this, below the incisura acetabuli, there is not infrequently a small projection, *tuberculum obturatorium posterius;* from its posterior margin the strong, sharp *spina ischiadica* (O. T. spine of ischium) projects backward and somewhat medianward. The deep notch between the spina ischiadica and the spina iliaca posterior inferior is called the *incisura ischiadica major* (O. T. great sacro-sciatic notch) (see also p. 129); a second notch, the *incisura ischiadica minor* (O. T. lesser sacro-sciatic notch), below the spina ischiadica, between this and the tuber ischiadicum, is flatter and covered with cartilage.

Extending backward and downward from the body or corpus is the triangularly prismatic *ramus superior ossis ischii;* its medial surface and the surface directed forward and lateralward is smooth. The surface directed backward and lateralward is rough and much thickened; it forms the *tuber ischiadicum* (O. T. tuberosity of the ischium). From the lower end of the ramus superior in front the thinner flat *ramus inferior ossis ischii* (O. T. ascending ramus) goes off, nearly at a right angle; it extends forward and upward and fuses with the inferior extremity of the ramus inferior ossis pubis.

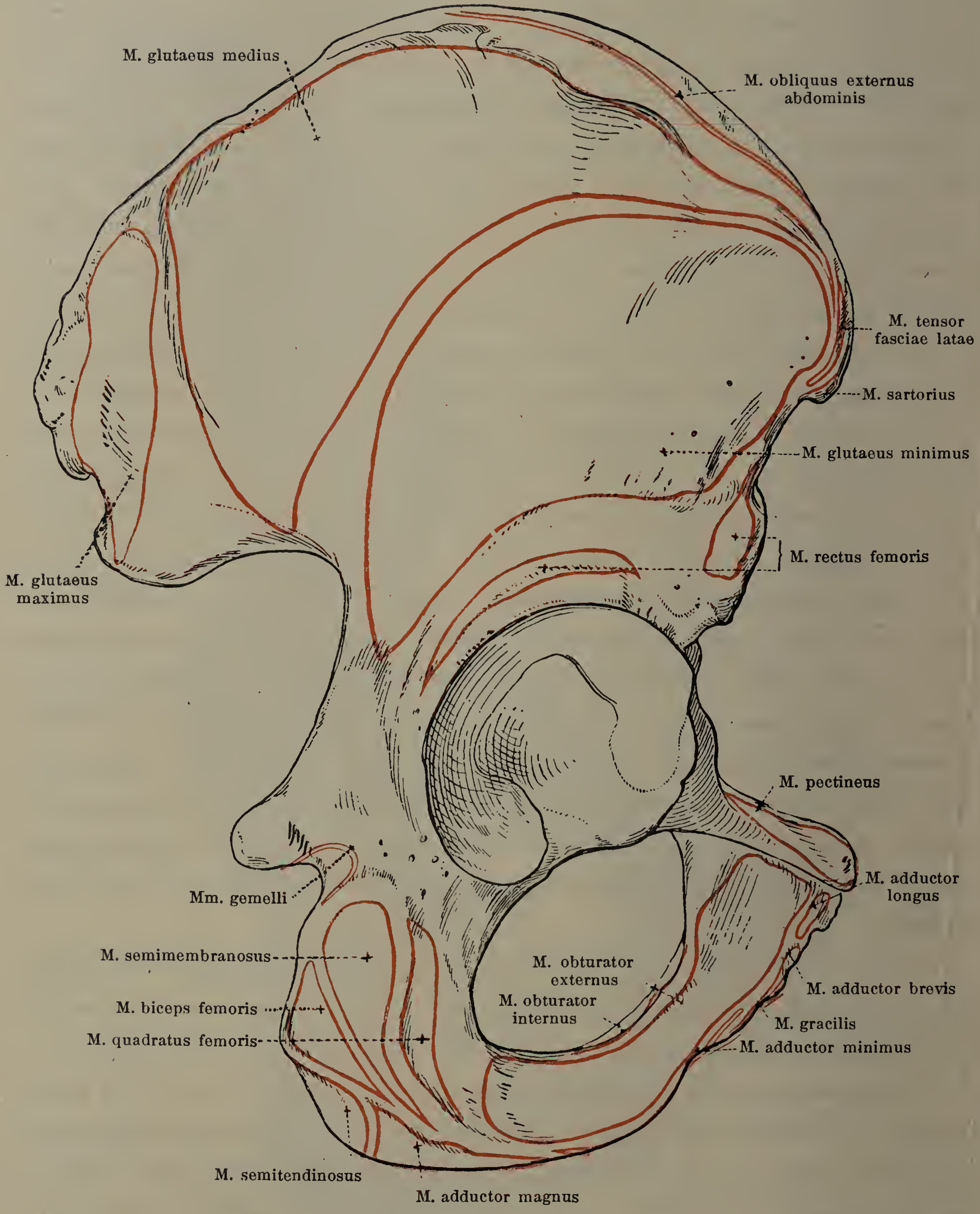


193. Right hip bone, *os coxae,* from in front and below.

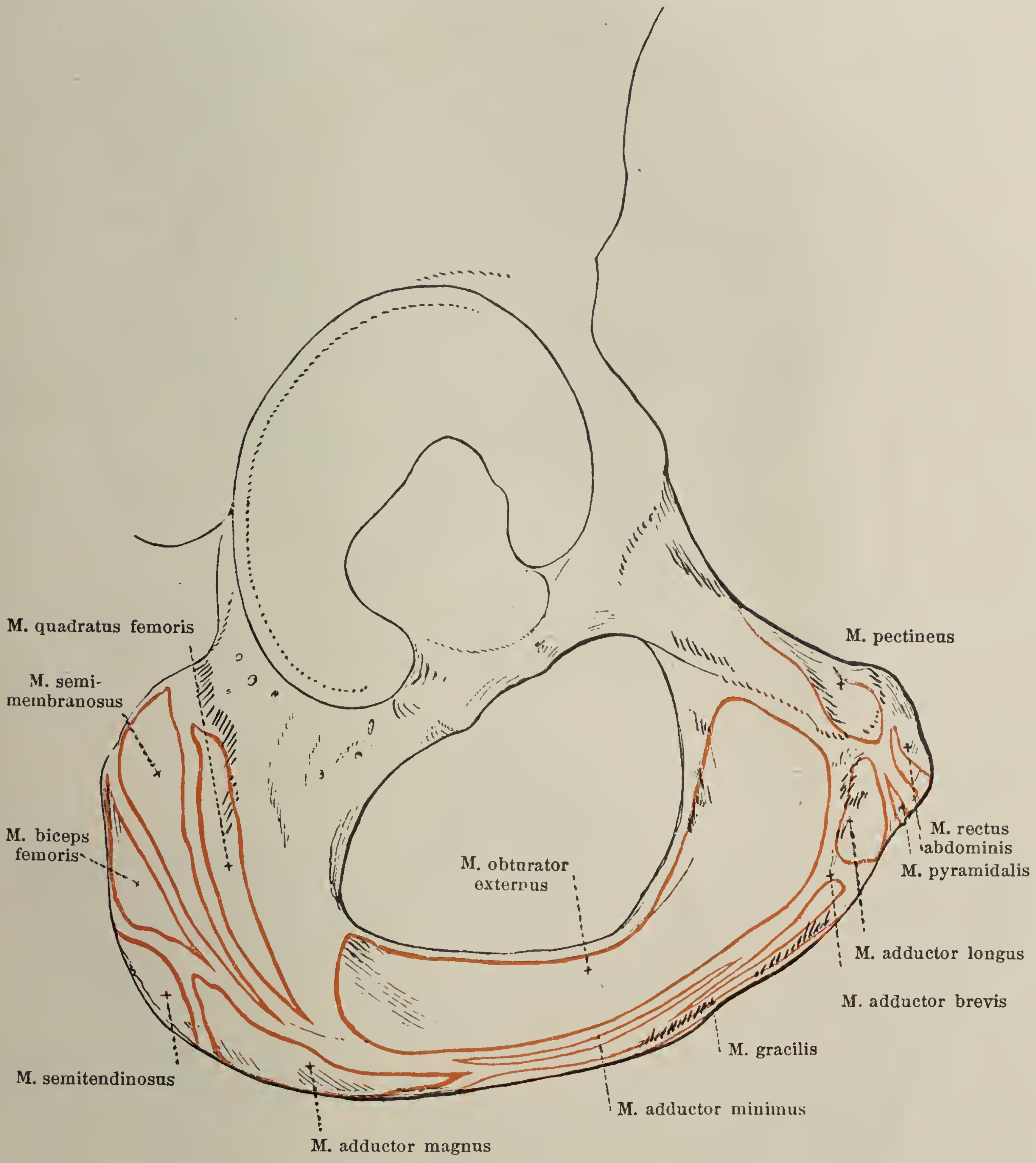
The ***os pubis*** (see also Figs. 191, 192 and 194—206) helps, with its thicker upper lateral portion, the *corpus ossis pubis,* to complete the acetabulum (see p. 129). Medianward and somewhat in front of this portion lies a flat projection, *eminentia iliopectinea,* formed by the os pubis and the os ilium in common. Extending forward, downward and medianward from the corpus *(body)* is the *ramus superior ossis pubis.* It is triangular and grows narrower from the outside in. Its posterior surface is smooth and somewhat concave. Its superior surface curved so as to be slightly saddle-shaped is directed at the same time obliquely lateralward and forward, is broad at its beginning at the acetabulum and at the eminentia iliopectinea, and gradually becomes narrower medianward; the posterior margin of this surface, *pecten ossis pubis,* projects in part to form a ridge, is continued behind and lateralward into the linea arcuata ossis ilium and forms with it and the projection between the facies pelvina and basis ossis sacri the *linea terminalis* of the pelvis; the anterior border, *crista obturatoria anterior,* arises from the incisura acetabuli, is rounded, slightly concave and ends near the median plane at a small rough projection, the *tuberculum pubicum* (O. T. spine of os pubis). The lower surface looks medianward at the same time forward and is continued lateralward into a groove, *sulcus obturatorius,* which ascends obliquely lateralward, backward and upward on the lower surface and ends on the inner surface; the sharp bony border, directed downward, by which this surface and groove are bounded medianward is called the *crista obturatoria posterior* and presents a small projection, *tuberculum obturatorium anterius.* The ramus superior ends medianward with an oval rough surface, *facies symphyseos* (O. T. symphysis pubis), for connection with the pubic bone of the other side.

The *ramus inferior ossis pubis* is the narrow, flat piece of bone which extends from the medial end of the ramus superior downward and lateralward and unites with the upper end of the ramus inferior ossis ischii.

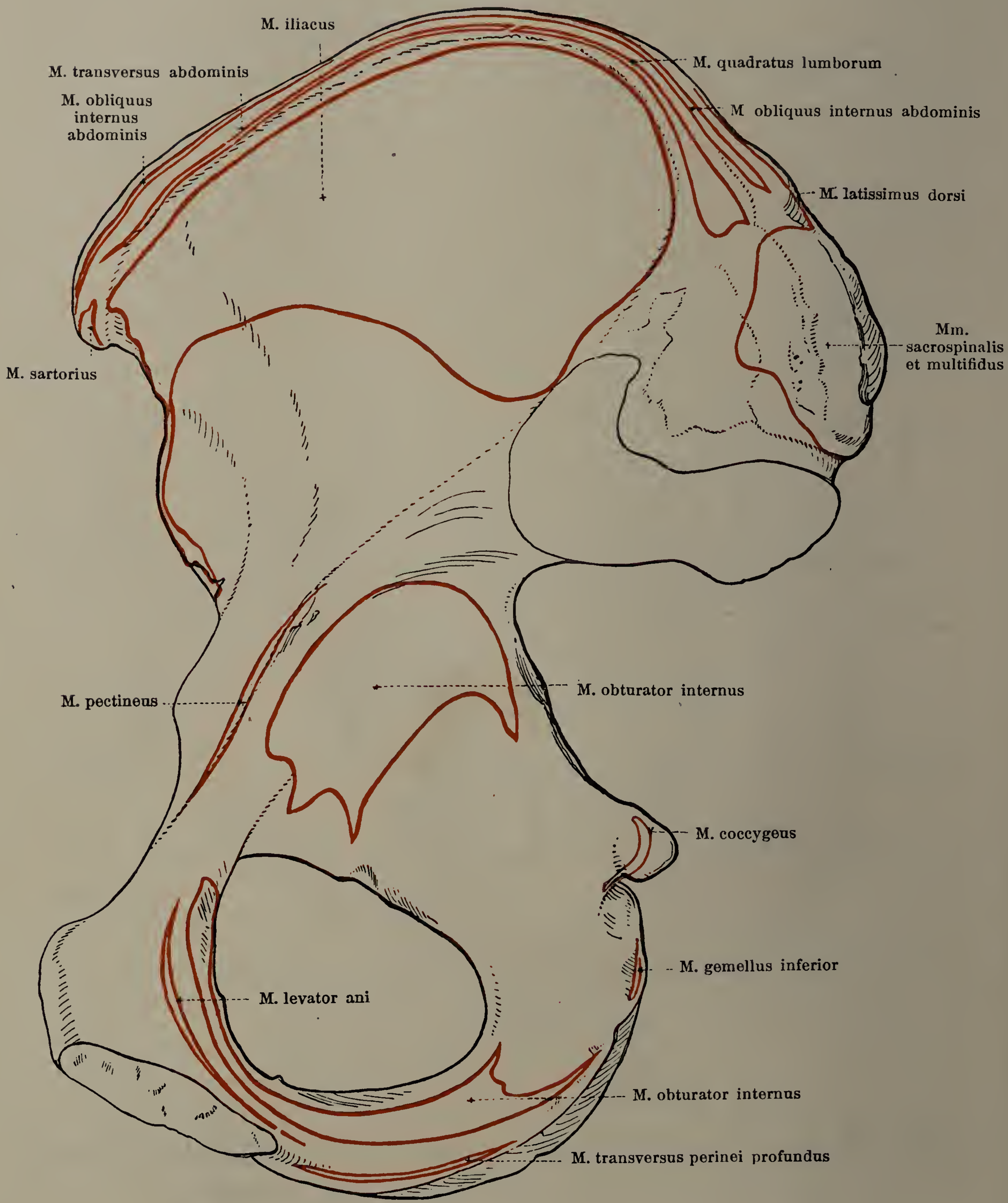
The ***foramen obturatum*** (see also Figs. 191, 192, 197 and 198) is a large triangular or oval opening which is bounded by the os ischii and the os pubis on all sides. Its margin is everywhere sharp, except in the upper lateral angle where the sulcus obturatorius is situated. The foramen obturatum is closed in the fresh pelvis by a thin membrane, *membrana obturatoria* (see Fig. 297), whose uppermost transverse bands are stretched out between the two tubercula obturatoria; the space thus left behind corresponds in its course to the sulcus obturatorius and is called the *canalis obturatorius* (for the a. and v. obturatoria; n. obturatorius).



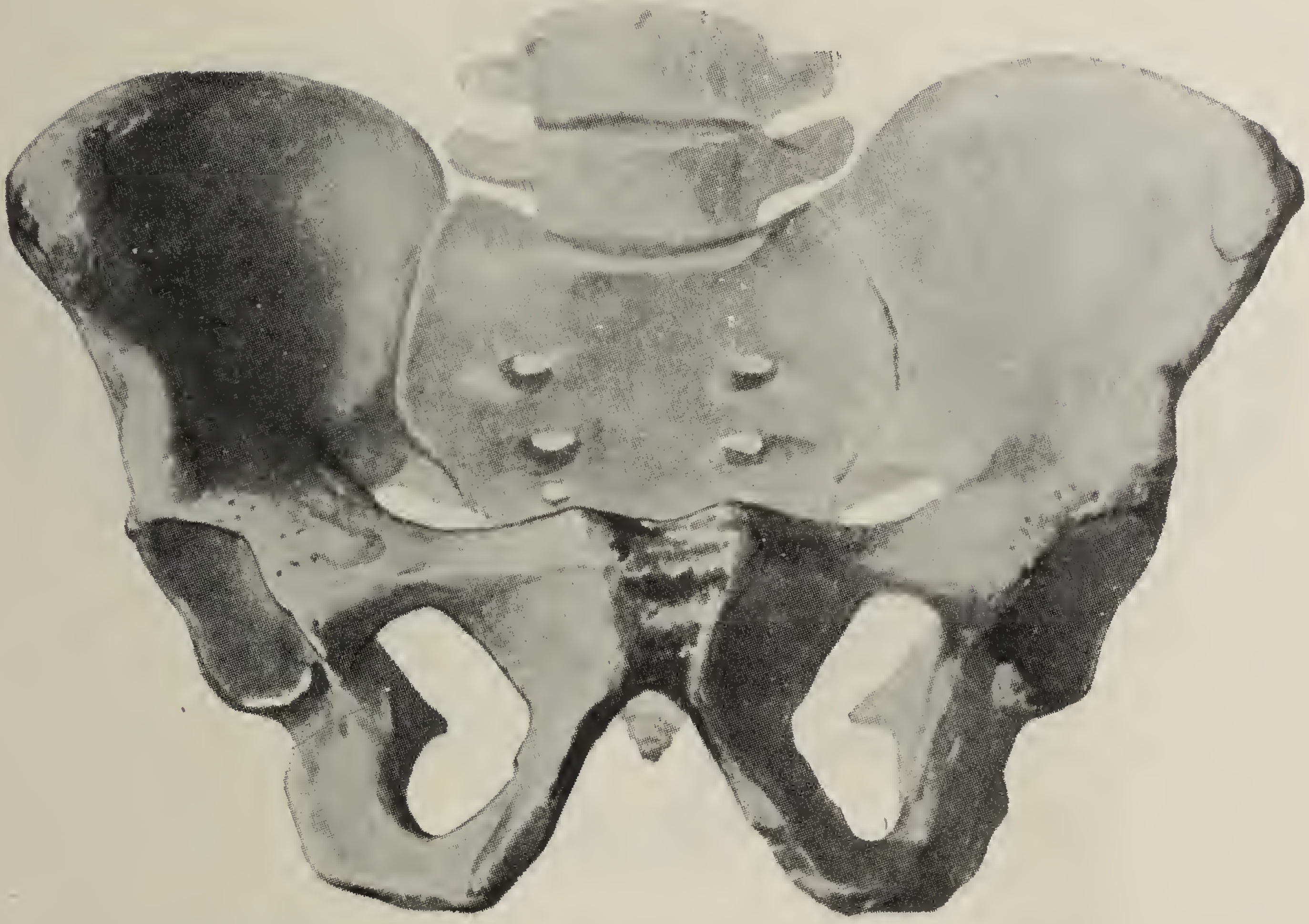
194. Right hip bone, *os coxae,* from behind and without, with the muscular attachments.



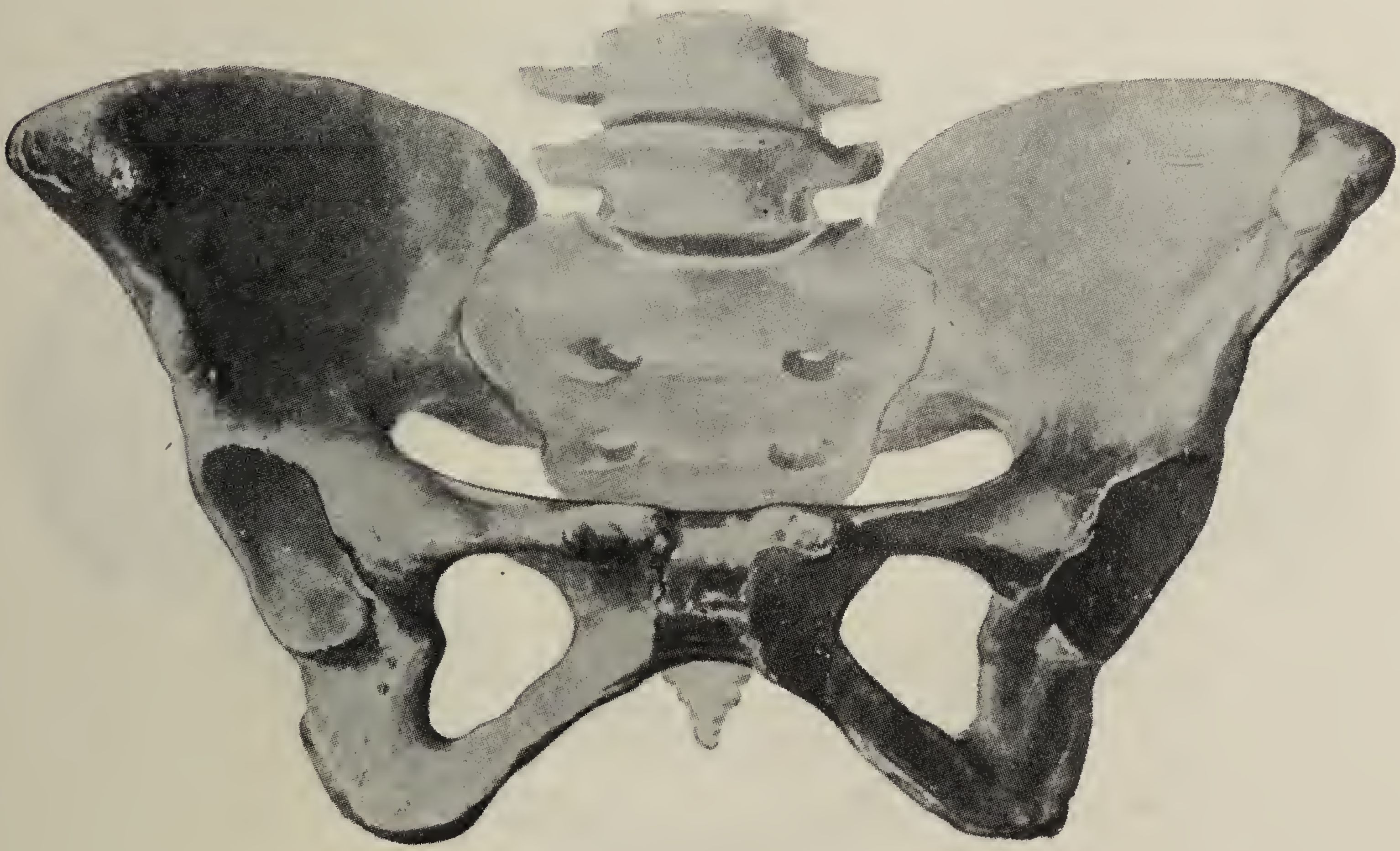
195. Right hip bone, *os coxae,* from in front and without and somewhat from below, with the muscular attachments.



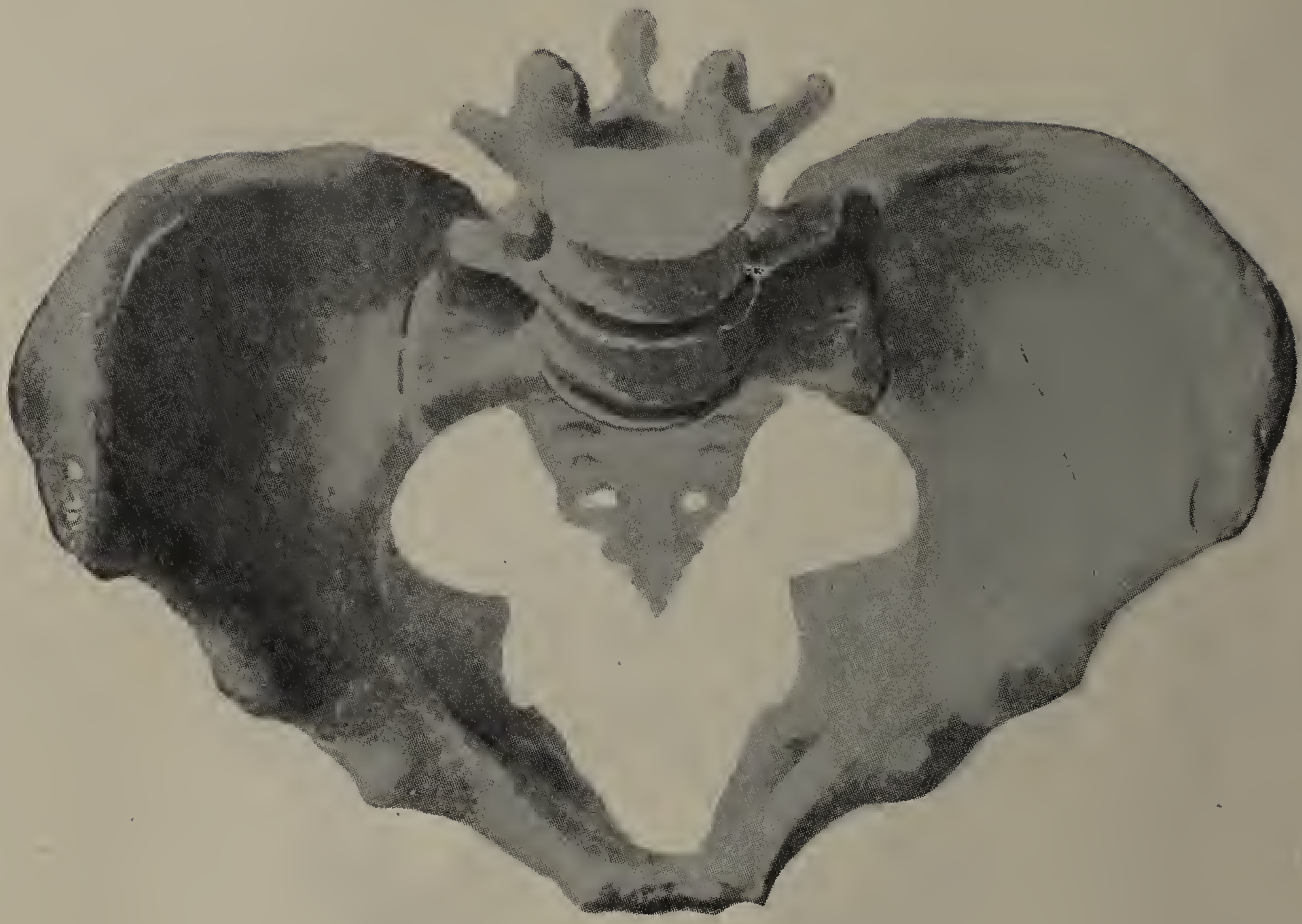
196. Right hip bone, *os coxae,* from within, with the muscular attachments.



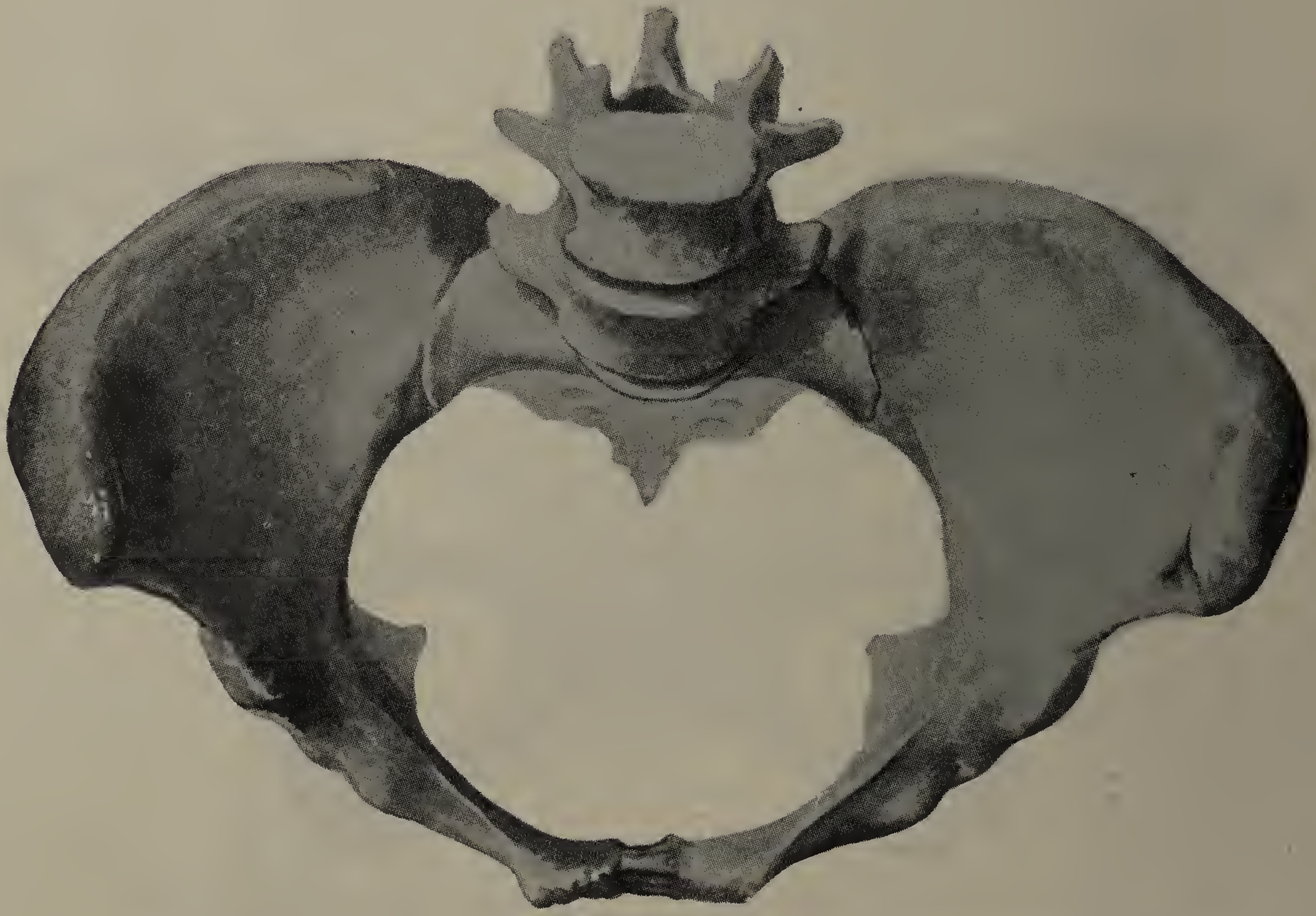
197. Male pelvis, ***pelvis,*** from in front and below.



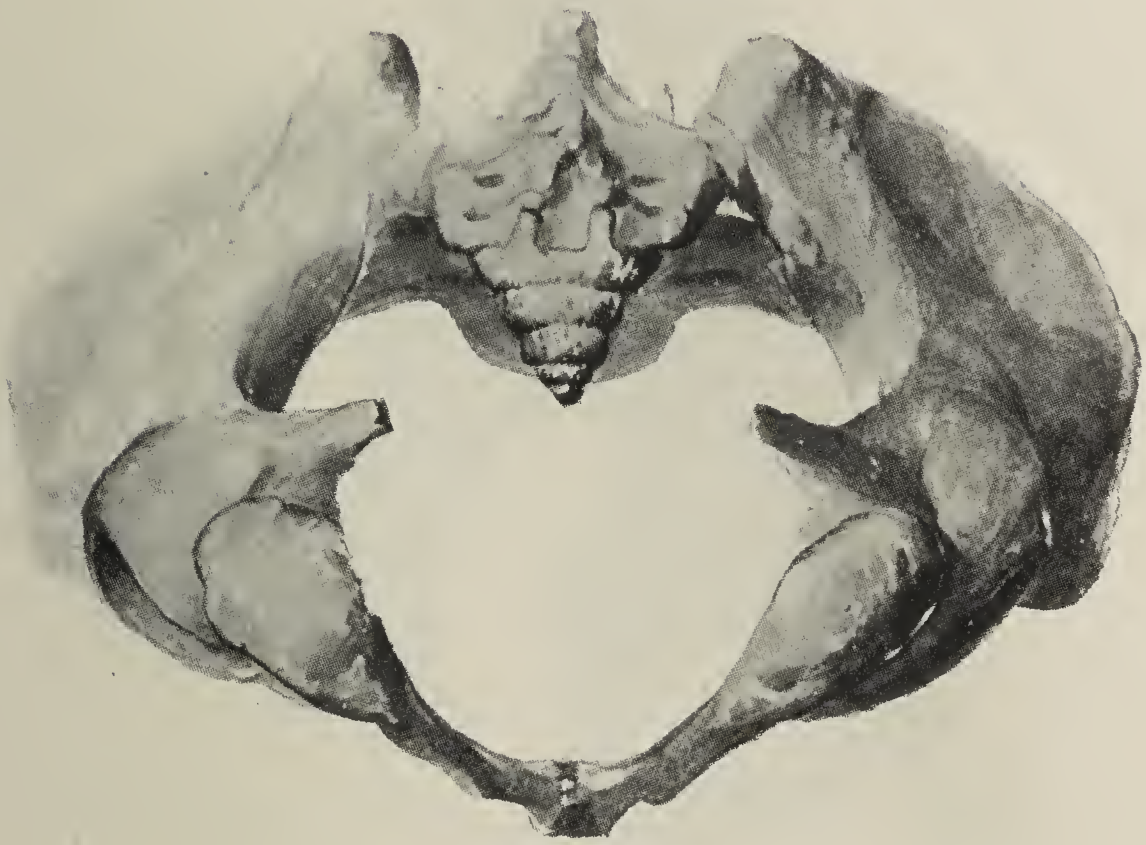
198. Female pelvis, ***pelvis,*** from in front and below.



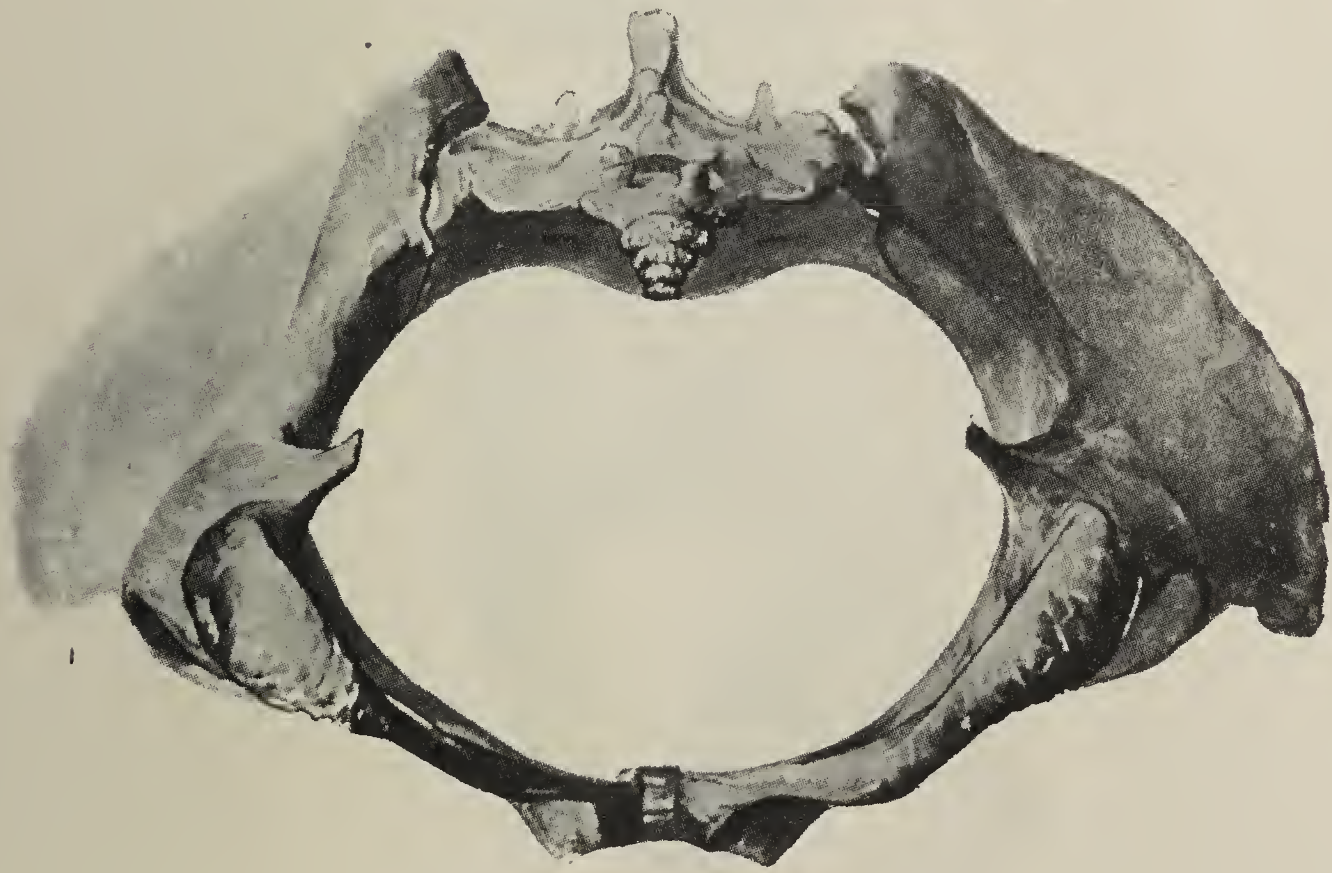
199. Male pelvis, ***pelvis,*** from in front and above.



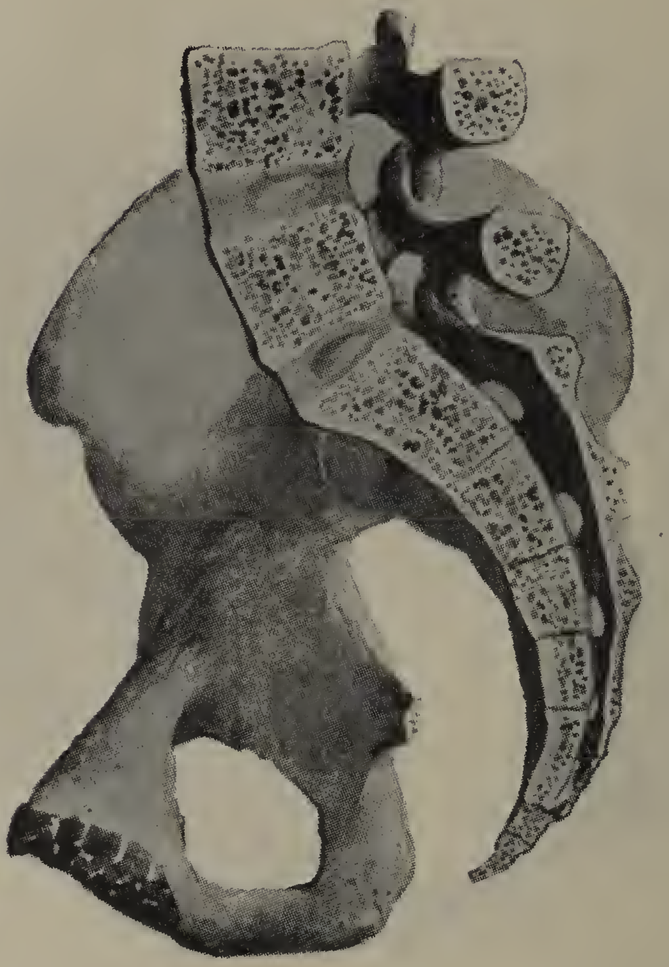
200. Female pelvis, ***pelvis,*** from in front and above.



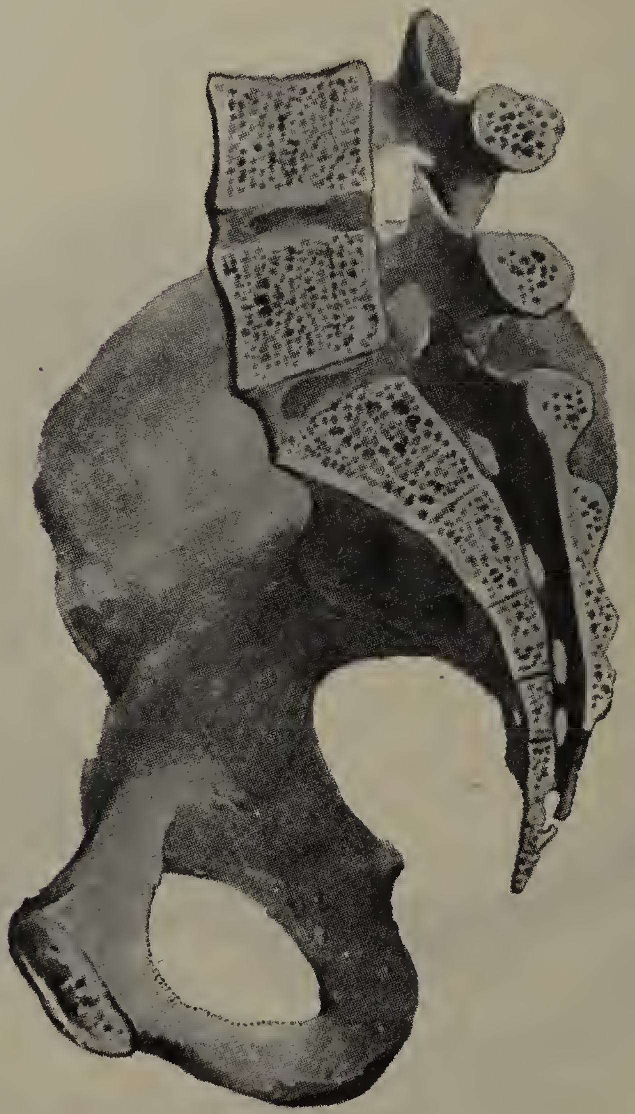
201. Male pelvis, *pelvis,* from below and behind.



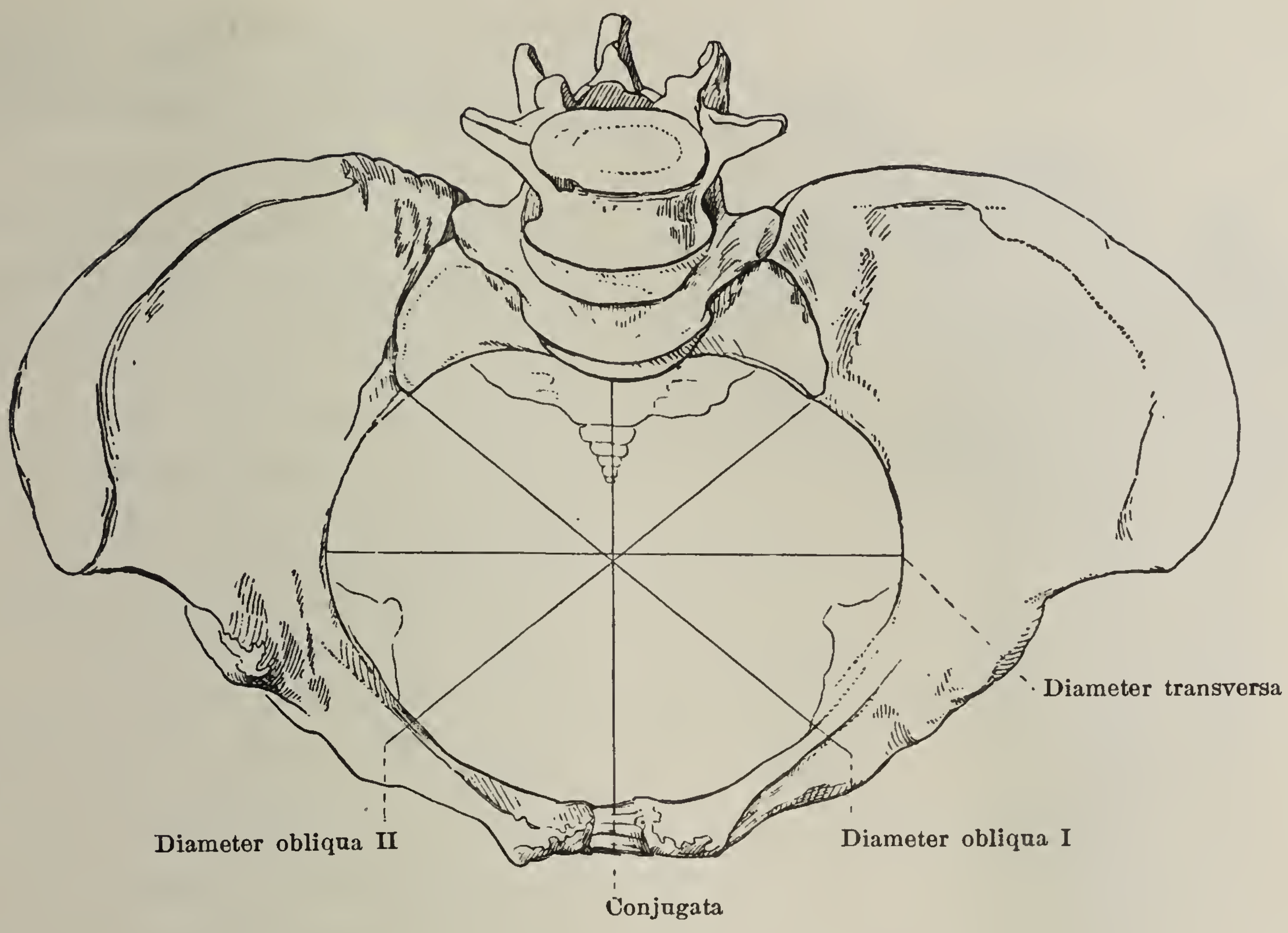
202. Female pelvis, *pelvis,* from below and behind.



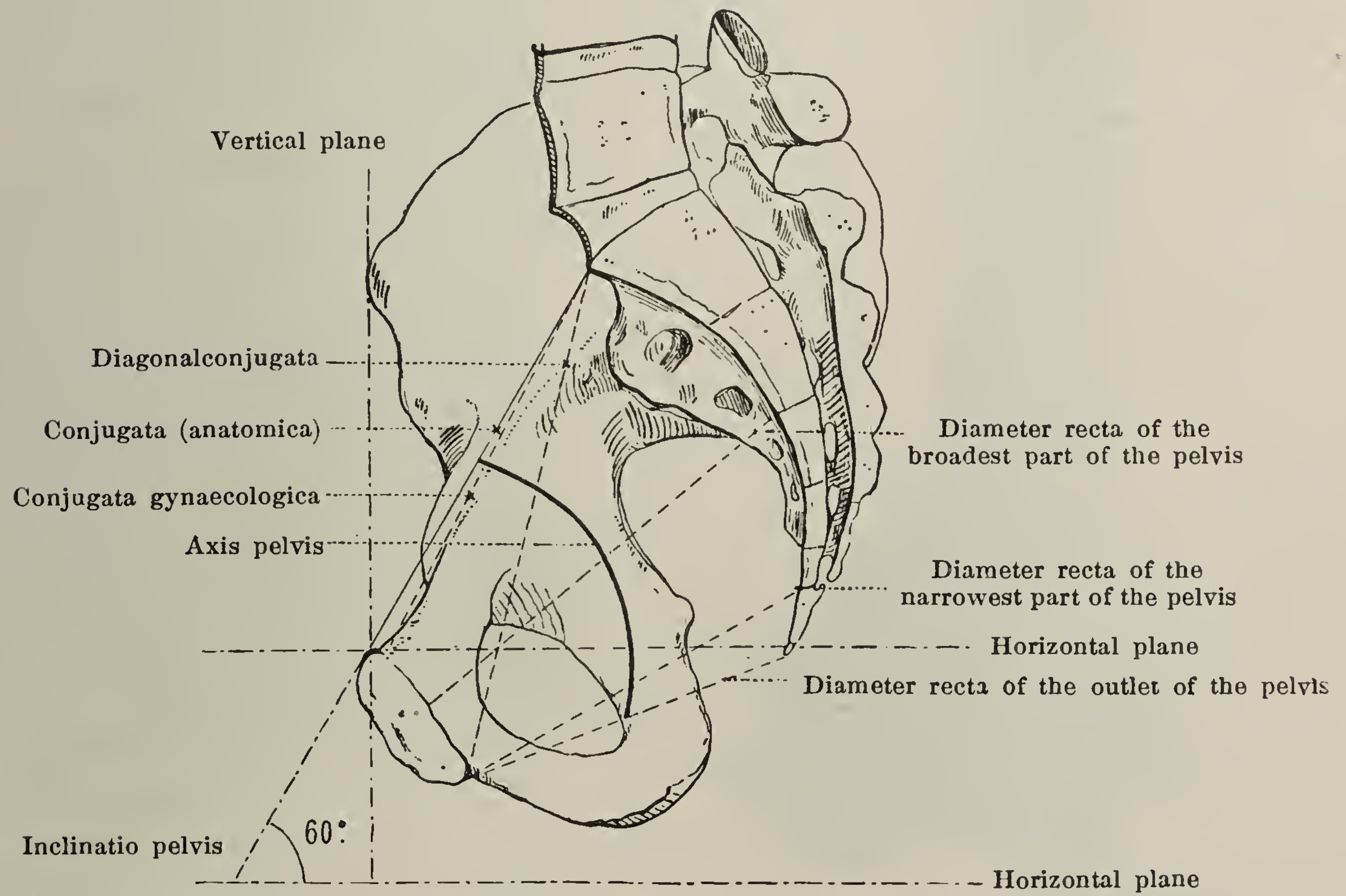
203. Male pelvis, ***pelvis,*** median section, right half, from the left.



204. Female pelvis, ***pelvis,*** median section, right half, from the left.

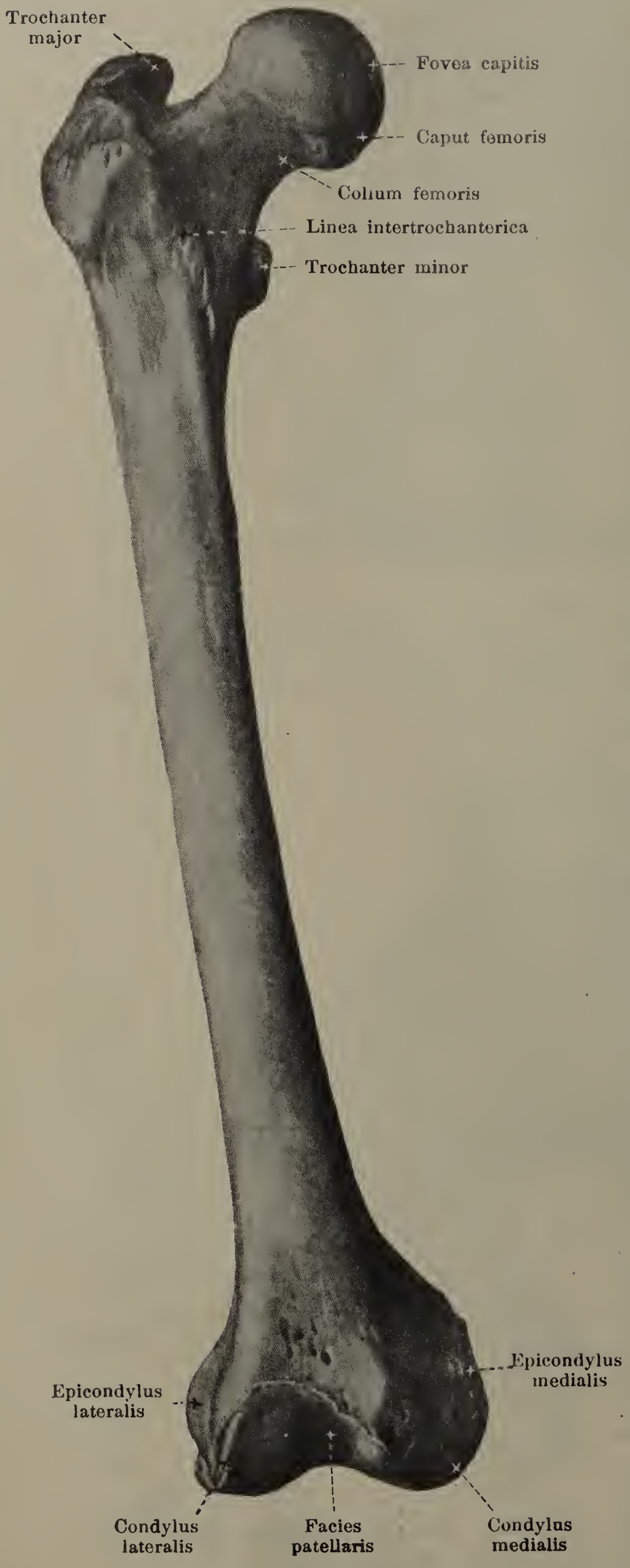


205. Female pelvis, ***pelvis,*** from in front and above, with pelvic diameters.


Vertical plane
Diagonalconjugata
Conjugata (anatomica)
Conjugata gynaecologica
Axis pelvis
Diameter recta of the broadest part of the pelvis
Diameter recta of the narrowest part of the pelvis
Horizontal plane
Diameter recta of the outlet of the pelvis
Inclinatio pelvis
60°
Horizontal plane

206. Female pelvis, ***pelvis,*** median section, right half, from the left, with pelvic diameters.

207. Right thigh bone, *femur,* from in front.



The **femur** (see also Figs. 208—217) *(thigh bone)* is the longest cylindrical bone of the human body and lies in the thigh; it articulates above with the acetabulum of the hip bone, below with the tibia and is so situated that its long axis is oblique in that the two thigh bones converge toward one another at their lower extremities. (For the development see p. 168.)

The thigh bone is divisible into a shaft or *corpus*, and two extremities.

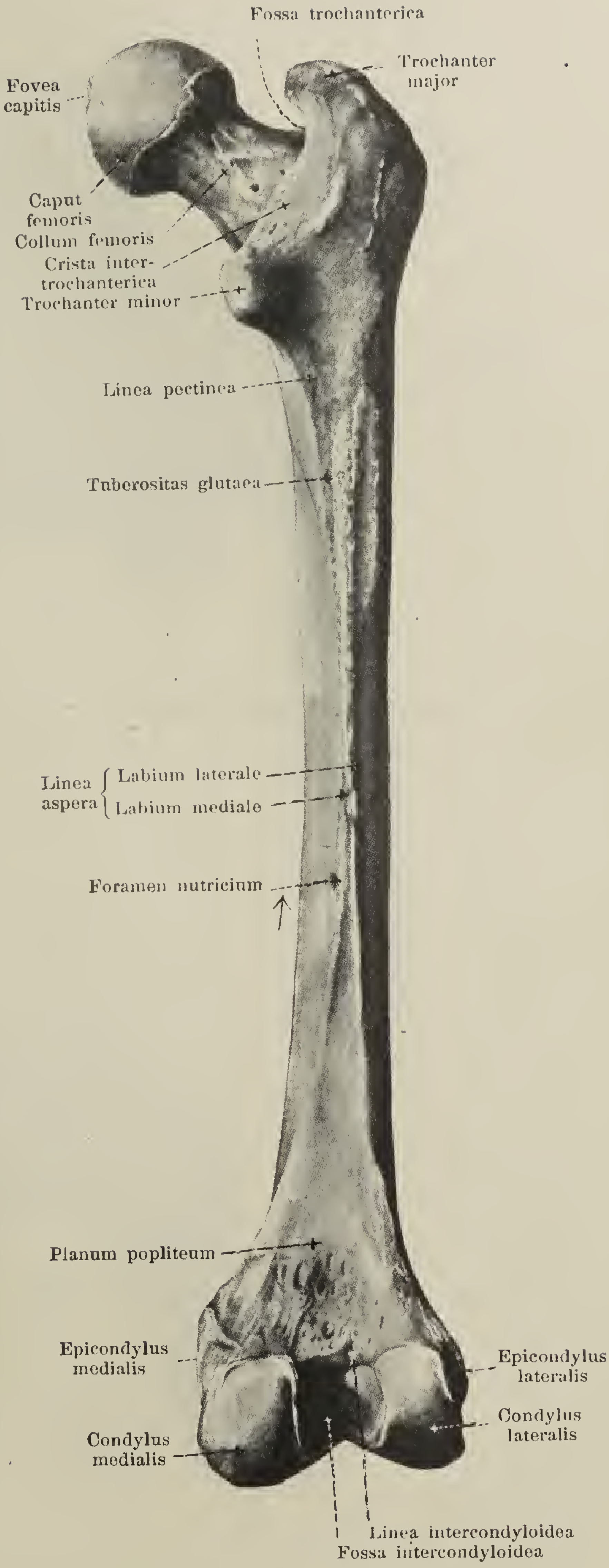
The ***corpus* femoris** *(shaft)* (see also Figs. 208, 209, 212, 216 and 217) is curved so as to be slightly convex in front and is nearly triangularly prismatic. Its anterior surface is very convexly curved in transverse direction and goes over without sharp limit into the two other surfaces, the medial and the lateral, which are also directed backward; these latter meet in the middle behind in a rough ridge, ***linea aspera***, on which two lips are distinguishable, an external, ***labium laterale***, and an internal, ***labium mediale***. Below and above, these two lips diverge; below they go to the two condyles and leave between them a flat, triangular field, ***planum popliteum*** (O. T. popliteal space). Above, the medial lip extends in most cases partly toward the trochanter minor and forms a tolerably distinct ridge; ***linea pectinea***, in part it bends below the trochanter minor forward and upward and is continued into the linea intertrochanterica; the lateral lip turns outward and goes over into an oblong rough field, ***tuberositas glutaea***, which sometimes projects like a comb as the so-called ***trochanter tertius*** (not shown in the figure).

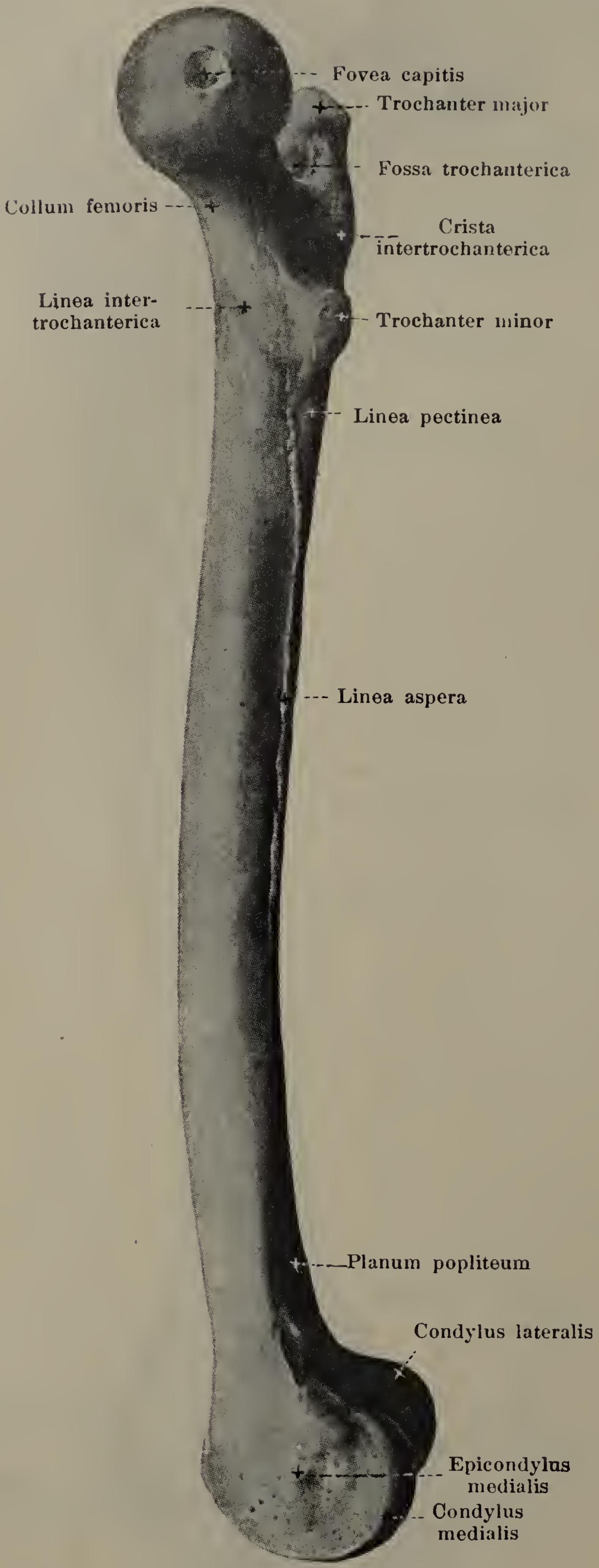
In the middle of the linea aspera can be seen usually one large or several smaller *foramina nutricia*, which lead into *canales nutricii*, directed proximalward.

208. Right thigh bone,

femur, from behind.

The ***upper extremity*** of the **femur** (see also Figs. 207, 209 and 213—217) supports the *caput femoris (head),* covered with cartilage, which is directed obliquely inward and upward and possesses medianward a small rough depression, the *fovea capitis femoris.* The head includes about three-fourths of the surface of a sphere. It sits upon the *collum femoris (neck)* which looks flattened out from before backward; the long axis of the neck is directed obliquely medianward and upward. At the place where the neck is united with the shaft there are two large projections from the posterior surface, the *trochanter major* and the *trochanter minor.* The trochanter major projects directly upward and backward and possesses on its medial surface, below the blunt tip which is bent medianward, a deep fossa, *fossa trochanterica* (O. T. digital fossa). The trochanter minor is situated lower down and looks also medianward. The *crista intertrochanterica* (O. T. intertrochanteric line), in part very markedly projecting, connects the two trochanters on the posterior surface. The much less prominent *linea intertrochanterica* (O. T. spiral line) runs on the anterior surface of the bone obliquely downward and medianward from the trochanter major, turns backward below the trochanter minor and becomes lost in the labium mediale of the linea aspera.

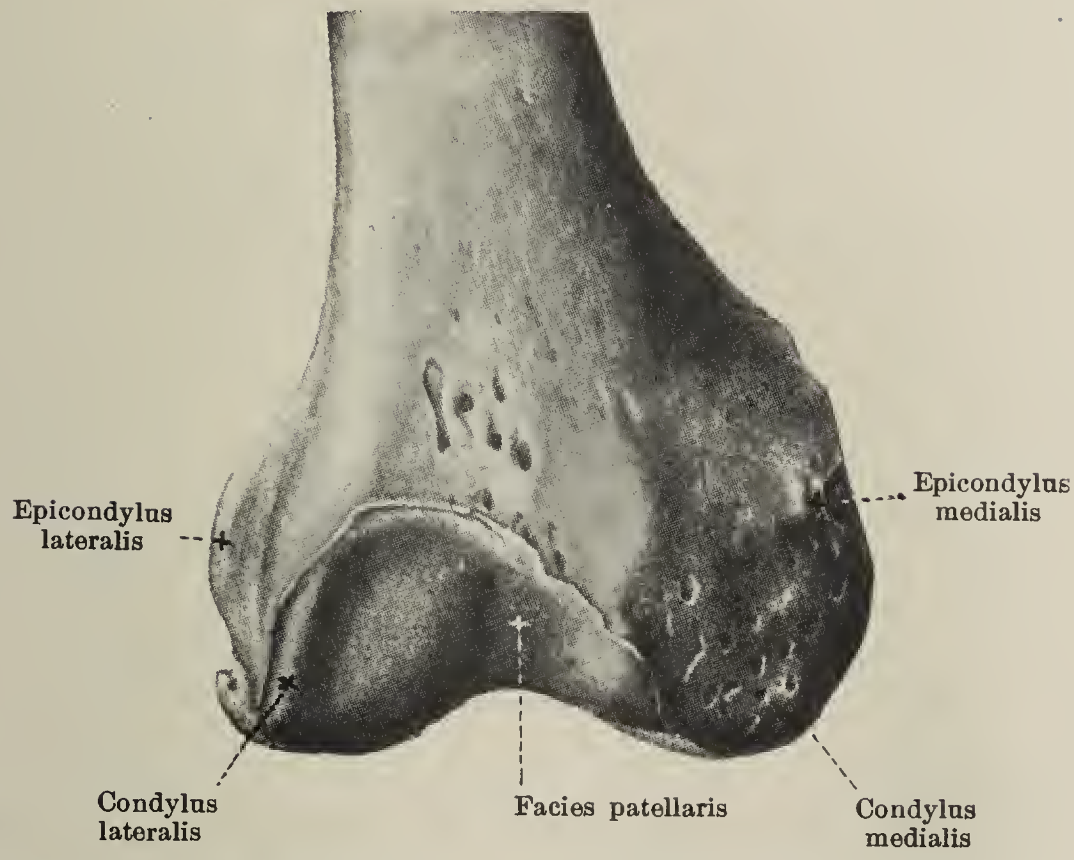




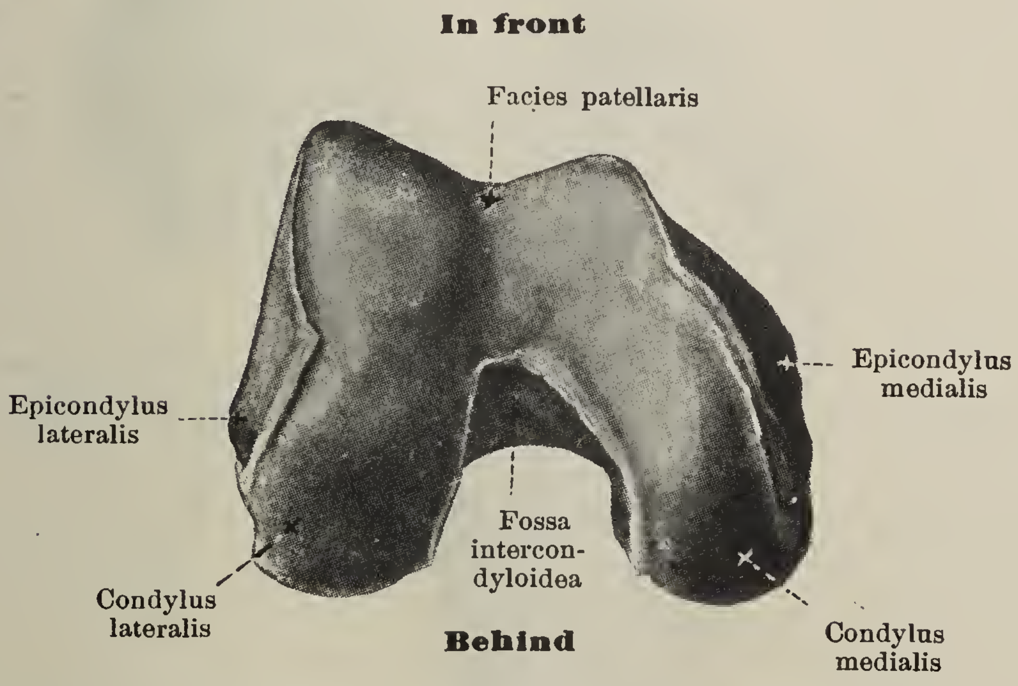
209. Right thigh bone,

femur, from within.

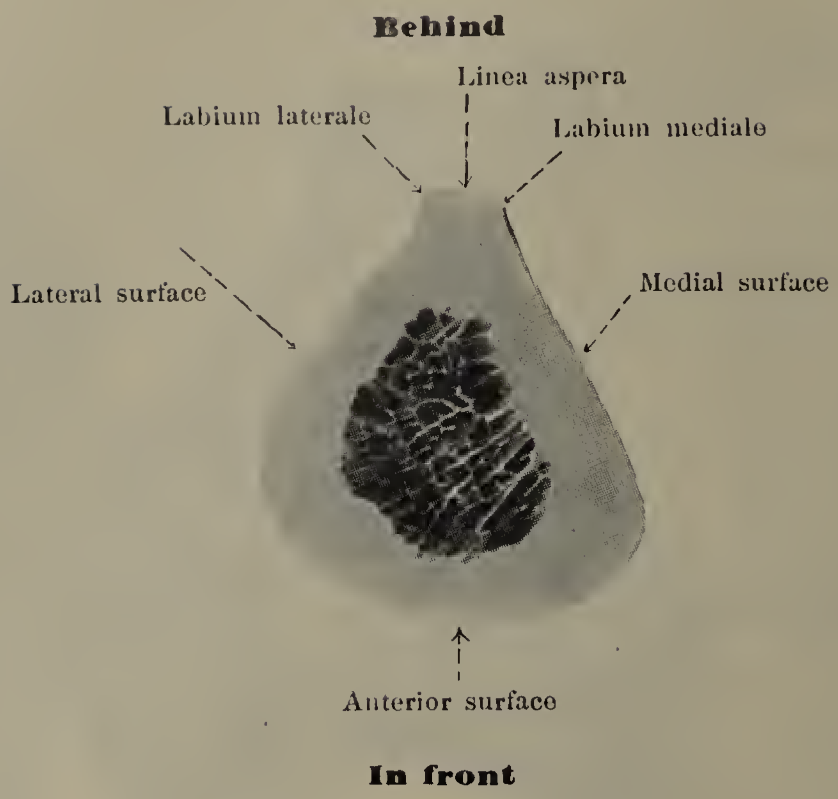
The ***inferior extremity*** of the **femur** (see also Figs. 207, 208, 210, 211, 216 and 217) is thickened and runs out into two strong *condyli (condyles),* covered with cartilage, which are especially developed backward, where they are, however, separated from one another by a deep notch, the *fossa intercondyloidea.* The *condylus medialis* (O. T. inner condyle) is larger than the *condylus lateralis* (O. T. outer condyle); both, on account of the oblique position of the thigh bone, are situated in the same horizontal plane in the body; the lateral condyle projects further forward in front than does the medial. Both are covered with cartilage behind, beneath, and in front, run together in front to form a common surface, the uppermost part of which, *facies patellaris,* is hollowed out in the middle like a groove and receives the patella partly when the knee is extended (see p. 149). The surface, covered with cartilage, is curved so as to be markedly convex in the sagittal direction and also somewhat convexly curved transversally at every condyle. The lateral surfaces of the condyles are rough and each presents a prominent nodule, the *epicondylus medialis* (O. T. inner tuberosity) on the condylus medialis and the *epicondylus lateralis* (O. T. outer tuberosity) on the condylus lateralis. The fossa intercondyloidea is rough and bounded above toward the planum popliteum by the *linea intercondyloidea.*



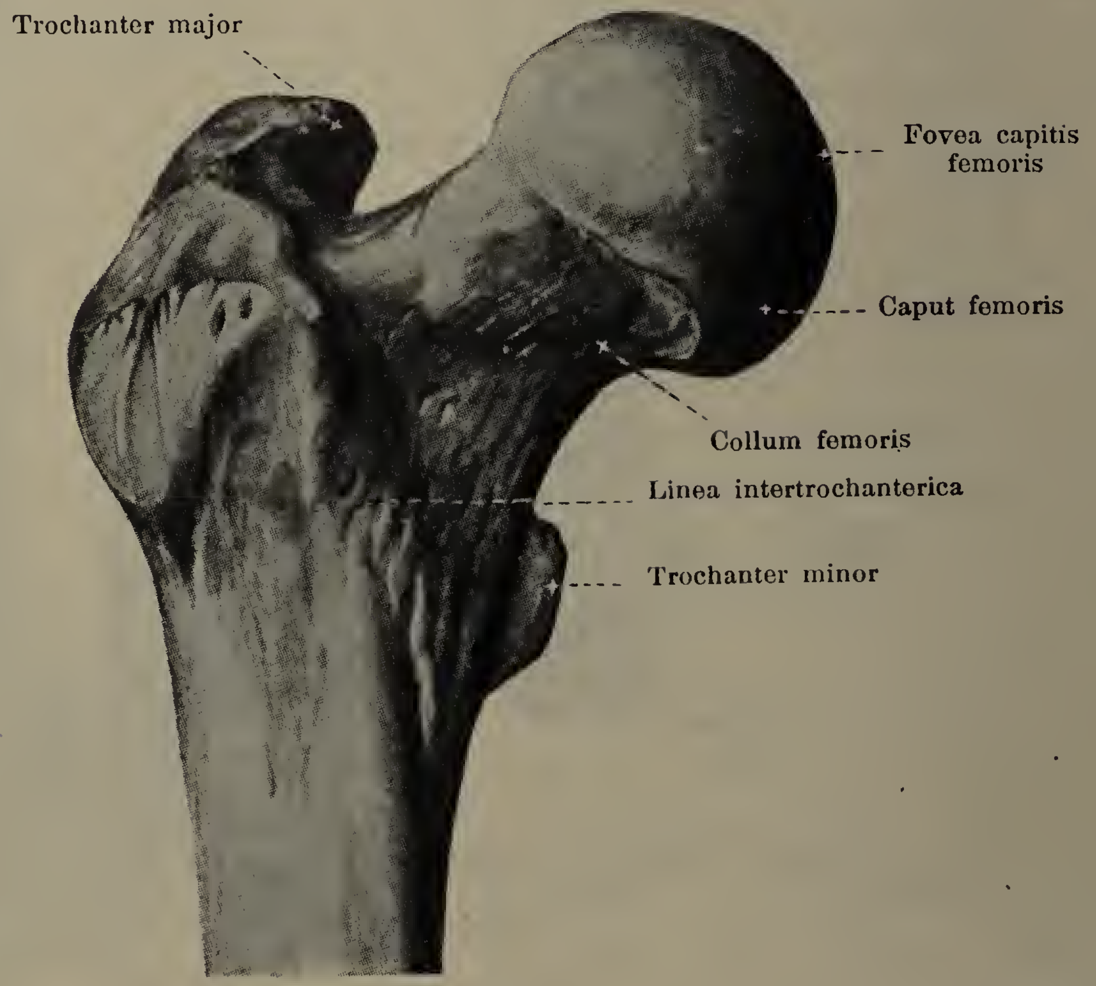
210. Right thigh bone, ***femur,*** inferior extremity, from in front.



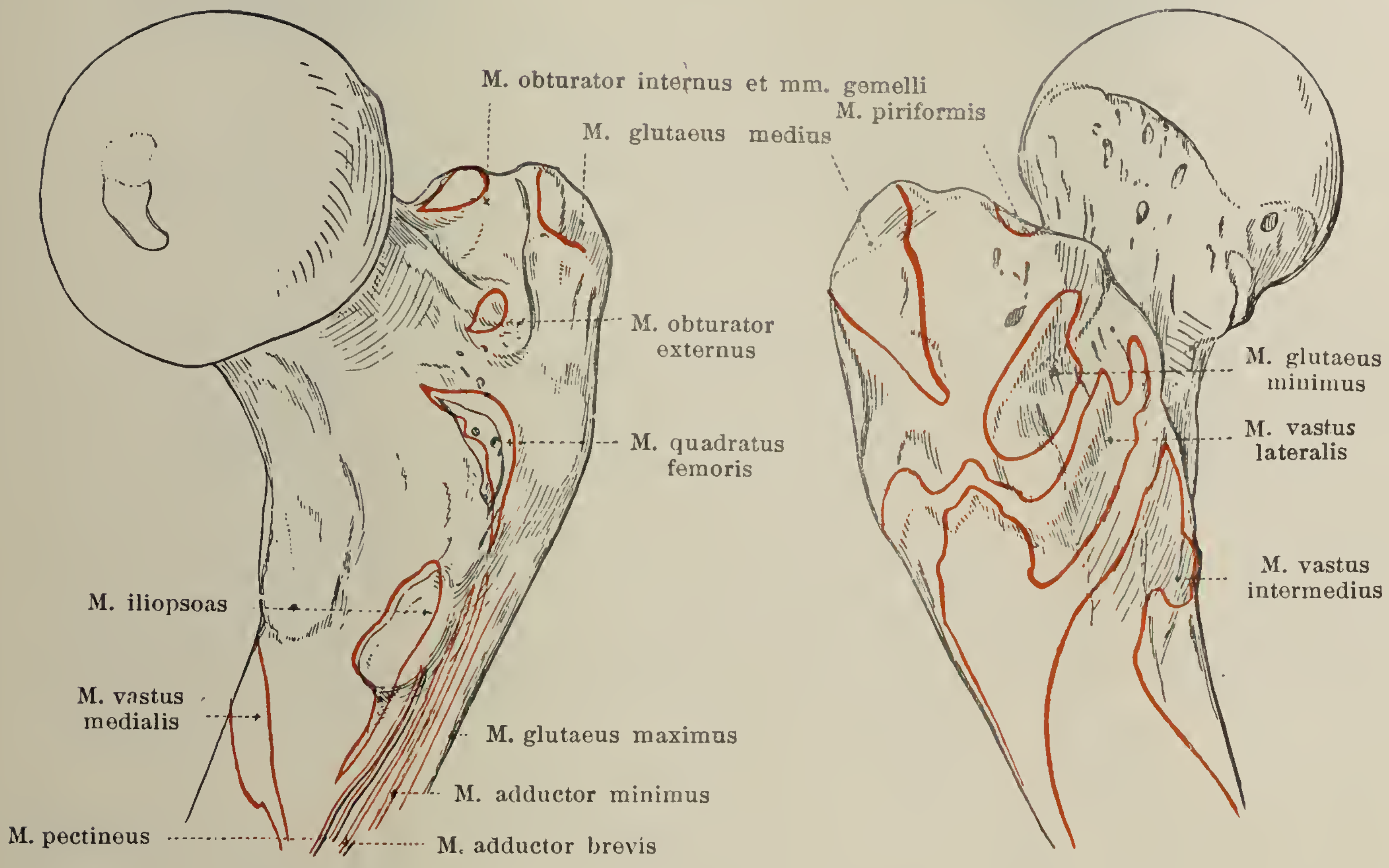
211. Right thigh bone, ***femur,*** inferior extremity, from below.



212. Transverse section through the middle of the right thigh bone, from above.

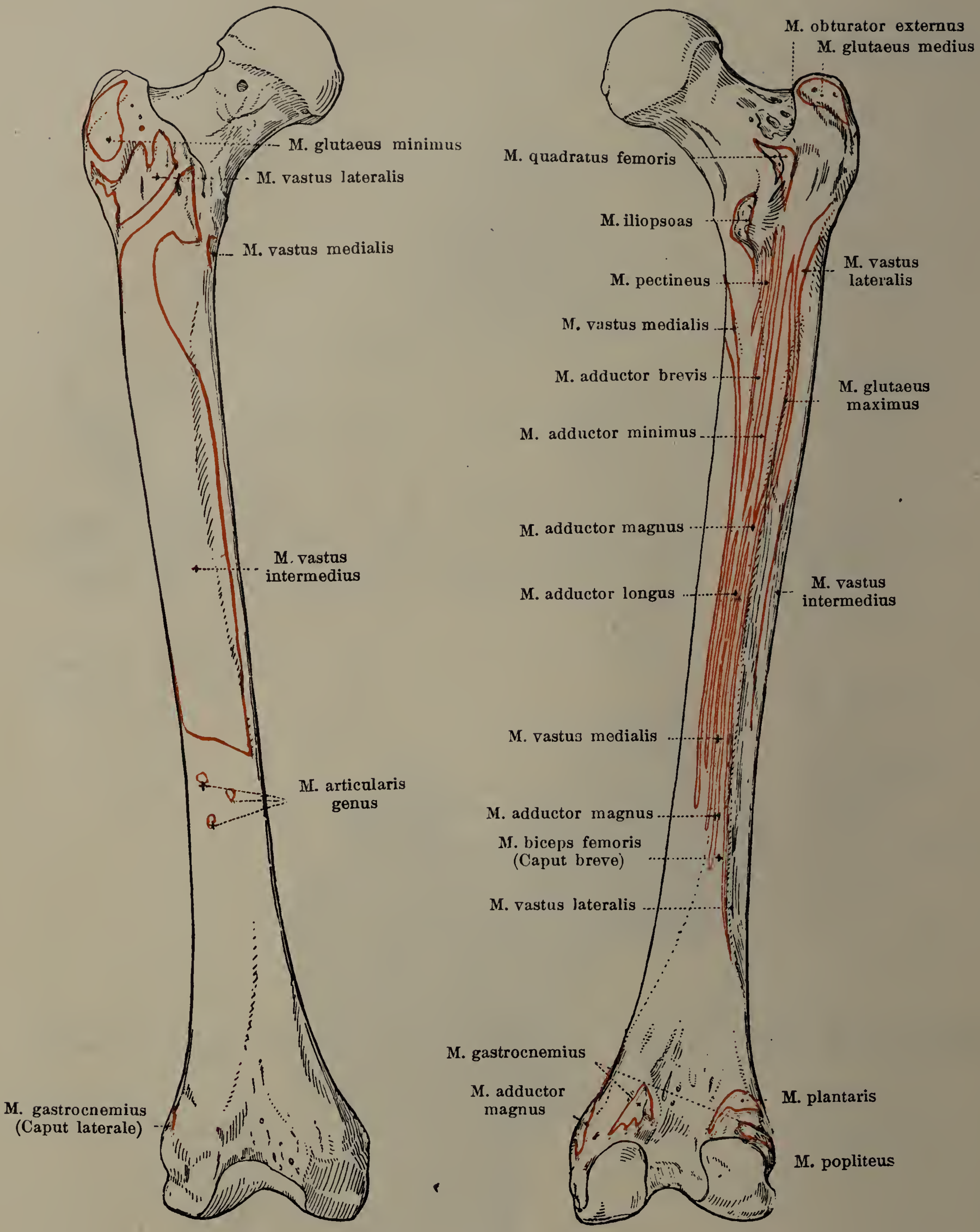


213. Right thigh bone, ***femur,*** upper extremity, from in front.

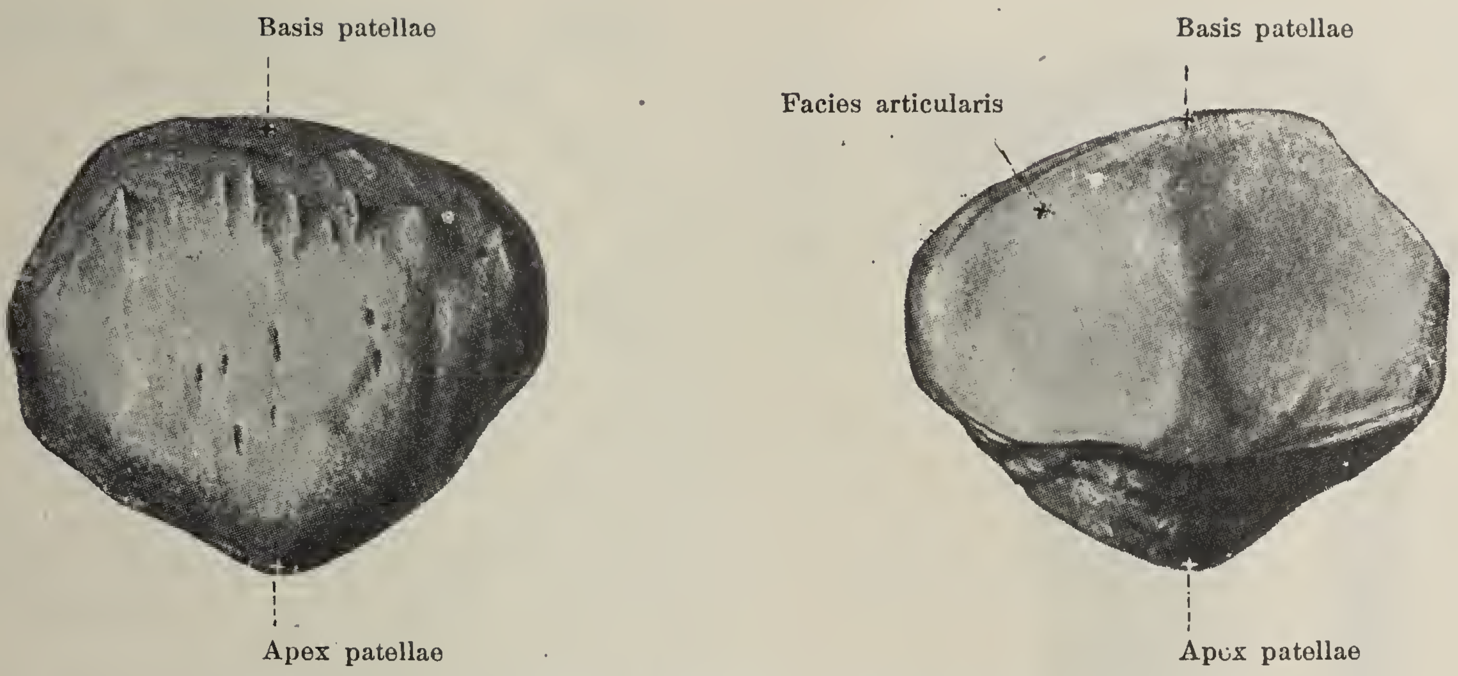


214 and 215. Right thigh bone, ***femur,*** upper extremity, with the muscular attachments,

from behind and within. from in front and without.



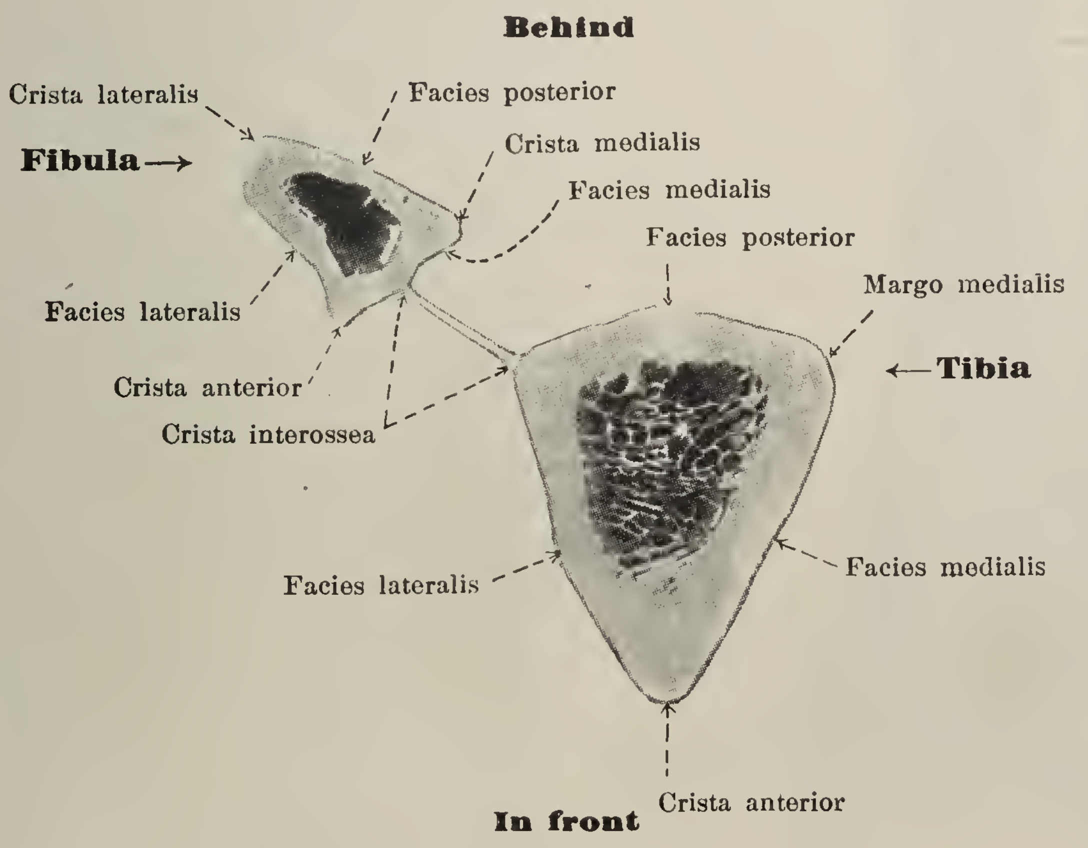
216 and 217. Right thigh bone, *femur*,
with the muscular attachments,
from in front. from behind



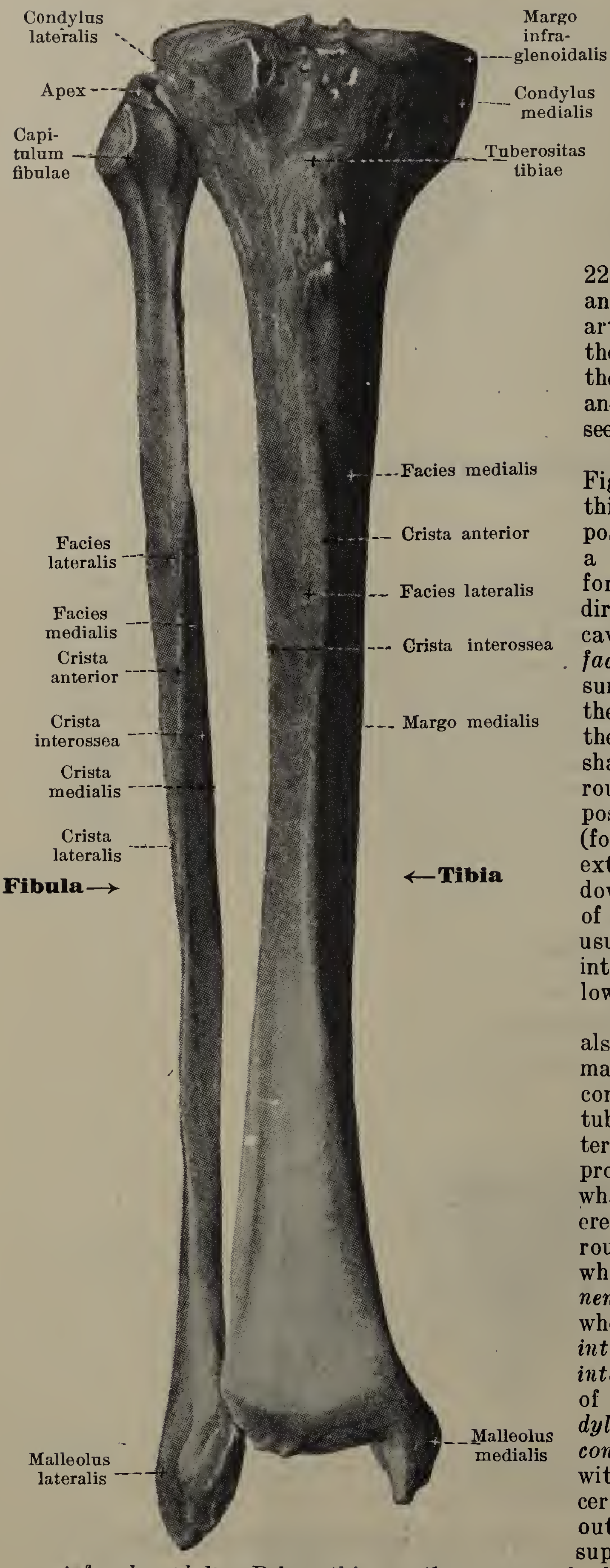
218 and 219. Right patella, *patella,*

from in front. from behind.

The **patella** *(knee-cap)* is a flat, rounded bone, which is intercalated in the terminal tendon of the m. quadriceps femoris and is situated in front of the lower extremity of the femur. It was formerly considered a large sesamoid bone, but is now looked upon as a typical skeleton element which, howewer, is in retrogression. The upper end is the broader, *basis patellae,* the lower end is somewhat pointed, *apex patellae,* the margins are but little sharpened. The anterior surface is rough. The posterior surface is for the most part covered with cartilage, *facies articularis,* and divided by a longitudinal projection into a somewhat larger lateral and a somewhat smaller medial part; when the knee is extended and the extensor muscles contracted it lies with its lower portion on the cartilage-covered facies patellaris femoris and with its upper portion above the same; in movements of flexion of the knee joint the patella glides downward and backward and slightly lateralward between the two joint-condyles of the femur, in front of the fossa intercondyloidea. (For the development see p. 168.)



220. Transverse section through the middle of the bones of the right leg, from above.



221. Right shin bone and calf bone,
***tibia et fibula,* from in front.**

The sleleton of the **leg,** *crus,* consists of two bones, *tibia* and *fibula,* articulating with each other at their upper and lower extremity.

The **tibia** *(shin bone)* (see also Figs. 220, 222—227 is a long, strong, cylindrical bone and lies in the medial portion of the leg; it articulates above with the femur, below with the tarsus and also, above and below, with the fibula. It is divisible into a shaft or *corpus* and two extremities. (For the development see p. 168.)

The ***corpus* tibiae** *(shaft)* (see also Figs. 220, 222, 226 and 227) in its upper two thirds is trilaterally prismatic, possesses a posterior, nearly flat surface, *facies posterior,* a smooth, somewhat convex surface looking forward and medianward, *facies medialis,* lying directly beneath the skin, and a slightly concave surface directed forward and lateralward, *facies lateralis.* Of the three borders where the surfaces meet, the anterior, *crista anterior,* is the sharpest and lies close beneath the skin; the laterally directed *crista interossa* is less sharp, while the medial, *margo medialis,* is rounded off. At the uppermost part of the posterior surface a rough ridge, *linea poplitea* (for the origin of the m. soleus) *(popliteal line),* extends obliquely from above and lateralward, downward and medianward. At the junction of the upper and middle thirds there is behind usually a large *foramen nutricium* which leads into a distally directed *canalis nutricius.* The lowermost third is quadrilateral (see p. 151).

The ***upper extremity*** of the **tibia** (see also Figs. 222, 223, 226 and 227) is broadened markedly to form on the two sides the tibial condyles, *condylus medialis* (O. T. internal tuberosity) and *condylus lateralis* (O. T. external tuberosity). Each of these possesses a proximally directed, triangularly oval, somewhat depressed *facies articularis superior,* covered with cartilage; between the two lies a rough surface, broader in front and behind, which is elevated in the middle to form the *eminentia intercondyloidea* (O. T. spinous process) where it ends in two small spurs, the *tuberculum intercondyloideum mediale* and the *tuberculum intercondyloideum laterale.* The area in front of the eminence is called the *fossa intercondyloidea anterior,* that behind it the *fossa intercondyloidea posterior.* The surface covered with cartilage is continued on each side for a certain distance upon the eminence. On the outer circumference of the facies articularis superior the bone falls suddenly as the *margo infraglenoidalis.* Below this, at the upper end of the crista anterior, a rough, broad, projecting spur is visible, the *tuberositas tibiae* (O. T. tubercle); at about the same level on the posterior lateral part of the condylus lateralis lies a small, flat, oval articular surface covered with cartilage for the capitulum fibulae, *facies articularis fibularis.*

222. Right shin bone and calf bone, *tibia et fibula*, from behind.

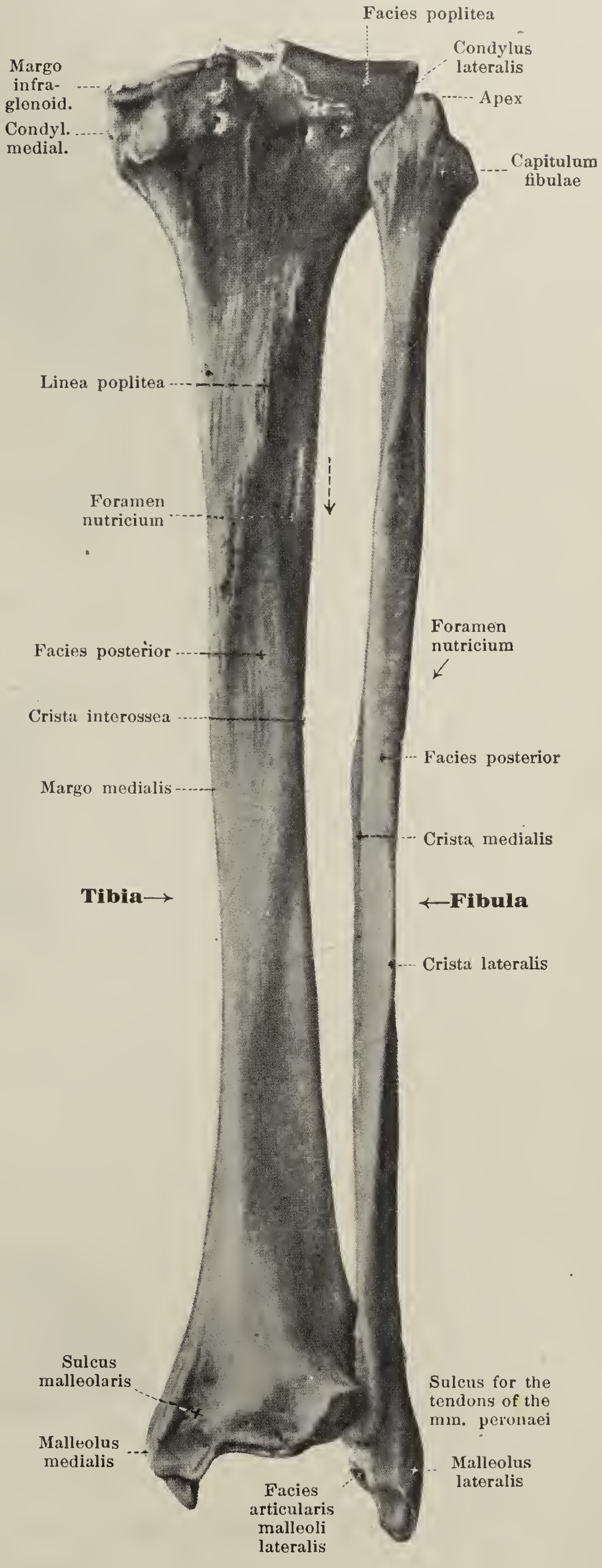
The ***inferior extremity*** of the **tibia** (see also Figs. 221 and 225—227) is quadrilateral, broadened a little; the lateral surface is somewhat concave below, *incisura fibularis* (not covered with cartilage) for the attachment of the malleolus lateralis fibulae; medianward a strong blunt process passes downward, *malleolus medialis* (O. T. internal malleolus), which on its medial surface is somewhat rough, on its lateral surface *(facies articularis malleoli medialis)* is covered with cartilage; on the posterior surface near the malleolus a shallow furrow extends downward, *sulcus malleolaris* (for the tendon of the m. tibialis posterior). The surface directed distalward, *facies articularis inferior* (for the talus), is slightly concave, quadrangular, and covered with cartilage which runs into that of the malleolus.

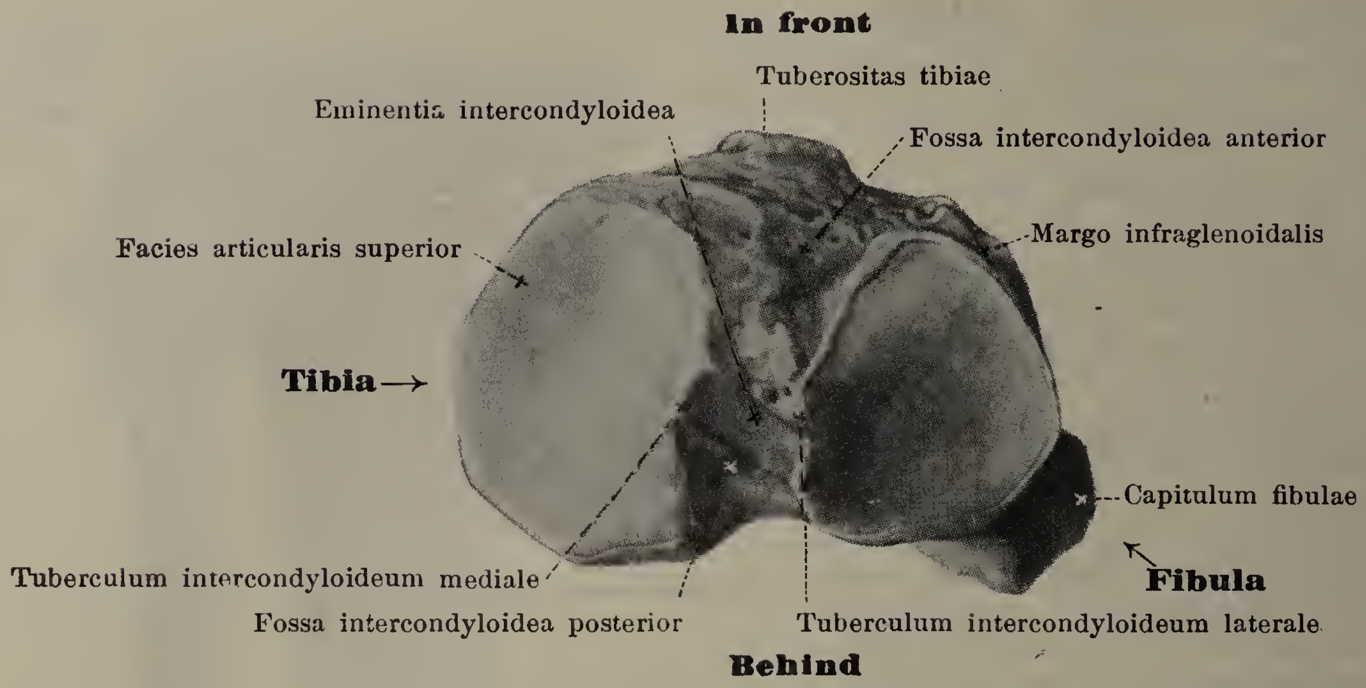
The **fibula** *(calf bone)* (see also Figs. 220, 221, 223—227) is a long, thin cylindrical bone situated in the lateral part of the leg and connected above with the tibia, below with the tibia and the tarsus. It is divisible into a shaft or *corpus*, an upper extremity, *capitulum*, and a lower extremity, *malleolus lateralis*. (For the development see p. 168.)

The ***corpus* fibulae** or *shaft* (see also Figs. 220, 221, 226 and 227) is nearly triangularly prismatic in shape, but appears at the same time twisted on its long axis. We may distinguish a posterior surface, *facies posterior*, an anterior medial, *facies medialis*, and an anterior lateral, *facies lateralis*. They are separated from one another by three borders; the sharpest looks forward, *crista anterior*, the second is directed medianward, *crista medialis*, and the third lateralward, *crista lateralis;* further, running down over the medial surface is the *crista interossea*, of markedly variable development. In the middle of the posterior surface a *foramen nutricium* leads into a *canalis nutricius* which runs distalward.

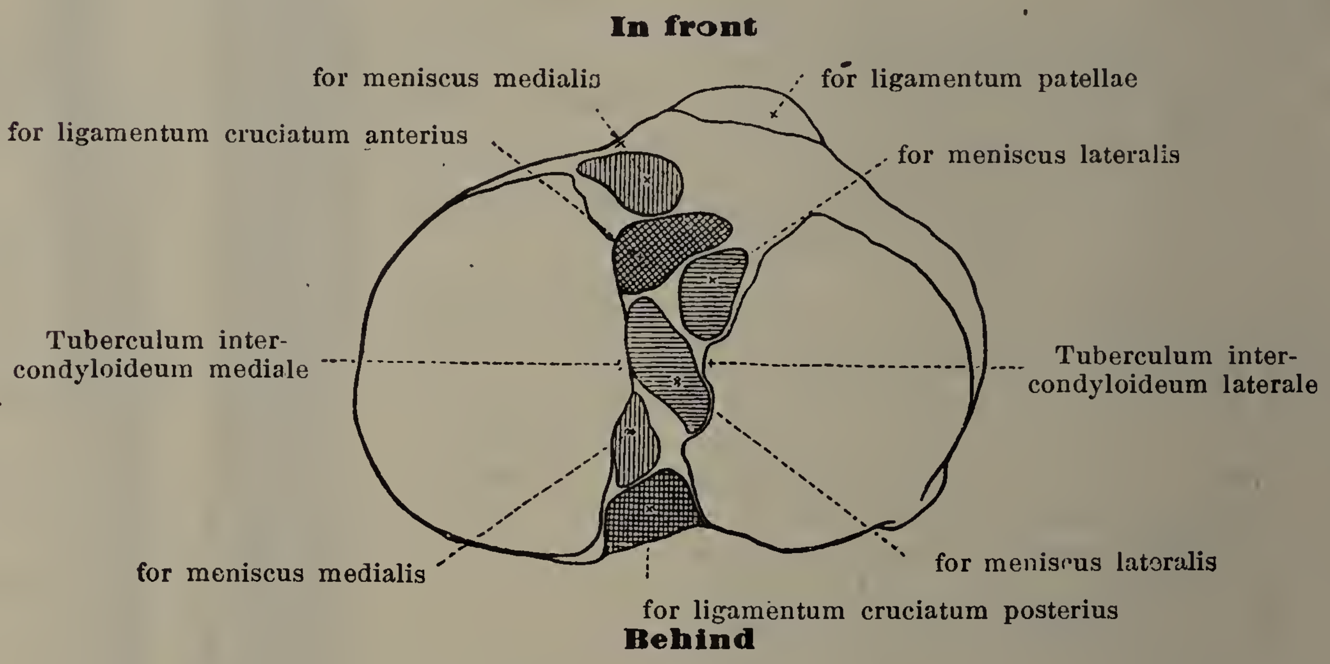
The ***capitulum* fibulae** *(head)* (see also Figs. 221, 223, 226 and 227) is somewhat thickened, runs out proximally into a blunt tip, *apex capituli fibulae*, and supports on its medial anterior surface a small flat joint surface, *facies articularis capituli.*

The ***malleolus lateralis*** (O. T. external malleolus) (see also Figs. 221 and 225—227) is thickened, projects further downward than the malleolus medialis and ends in a blunt tip. On its medial surface it is covered with cartilage, *facies articularis malleoli lateralis* (for the talus), and, above this surface, it lies in the incisura fibularis tibiae. The other surfaces are rough; on the posterior surface a shallow furrow for the tendons of the mm. peronaei is visible.

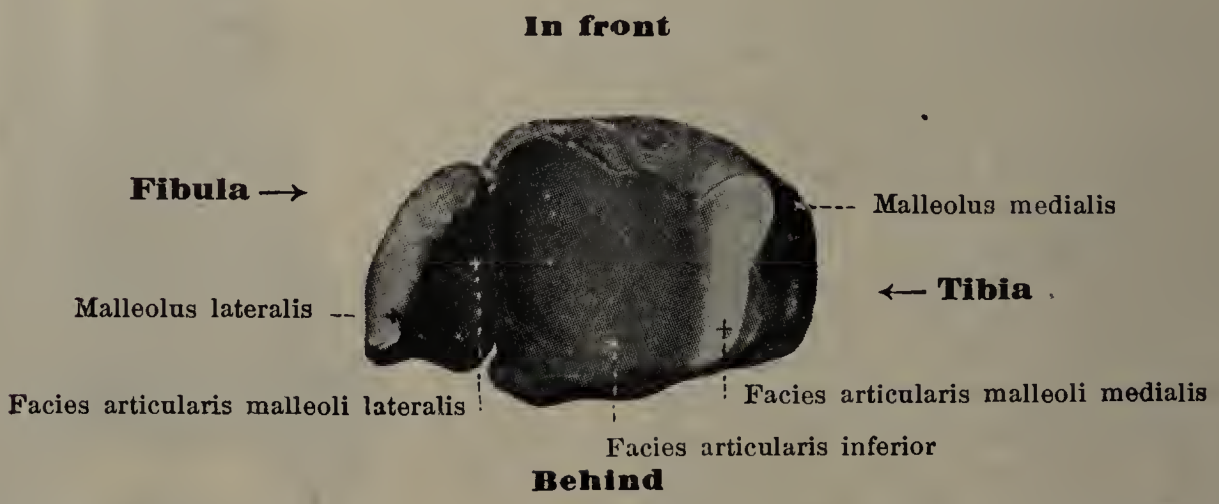



In front
Tuberositas tibiae
Eminentia intercondyloidea
Fossa intercondyloidea anterior
Facies articularis superior
Margo infraglenoidalis
Tibia
Capitulum fibulae
Fibula
Tuberculum intercondyloideum mediale
Fossa intercondyloidea posterior
Tuberculum intercondyloideum laterale
Behind

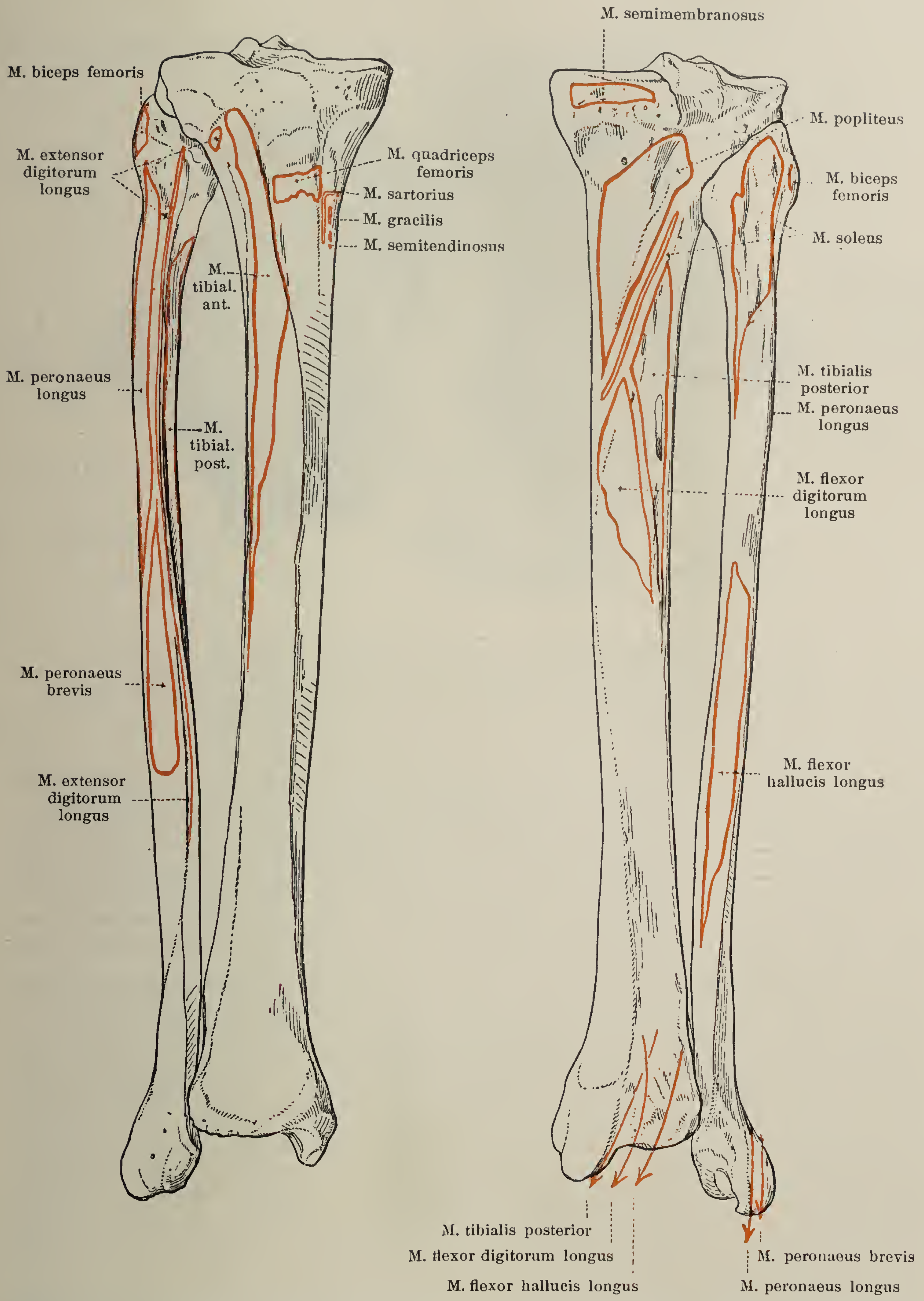
223. Right tibia and fibula, *tibia et fibula,* from above.


In front
for meniscus medialis
for ligamentum patellae
for ligamentum cruciatum anterius
for meniscus lateralis
Tuberculum intercondyloideum mediale
Tuberculum intercondyloideum laterale
for meniscus medialis
for meniscus lateralis
for ligamentum cruciatum posterius
Behind

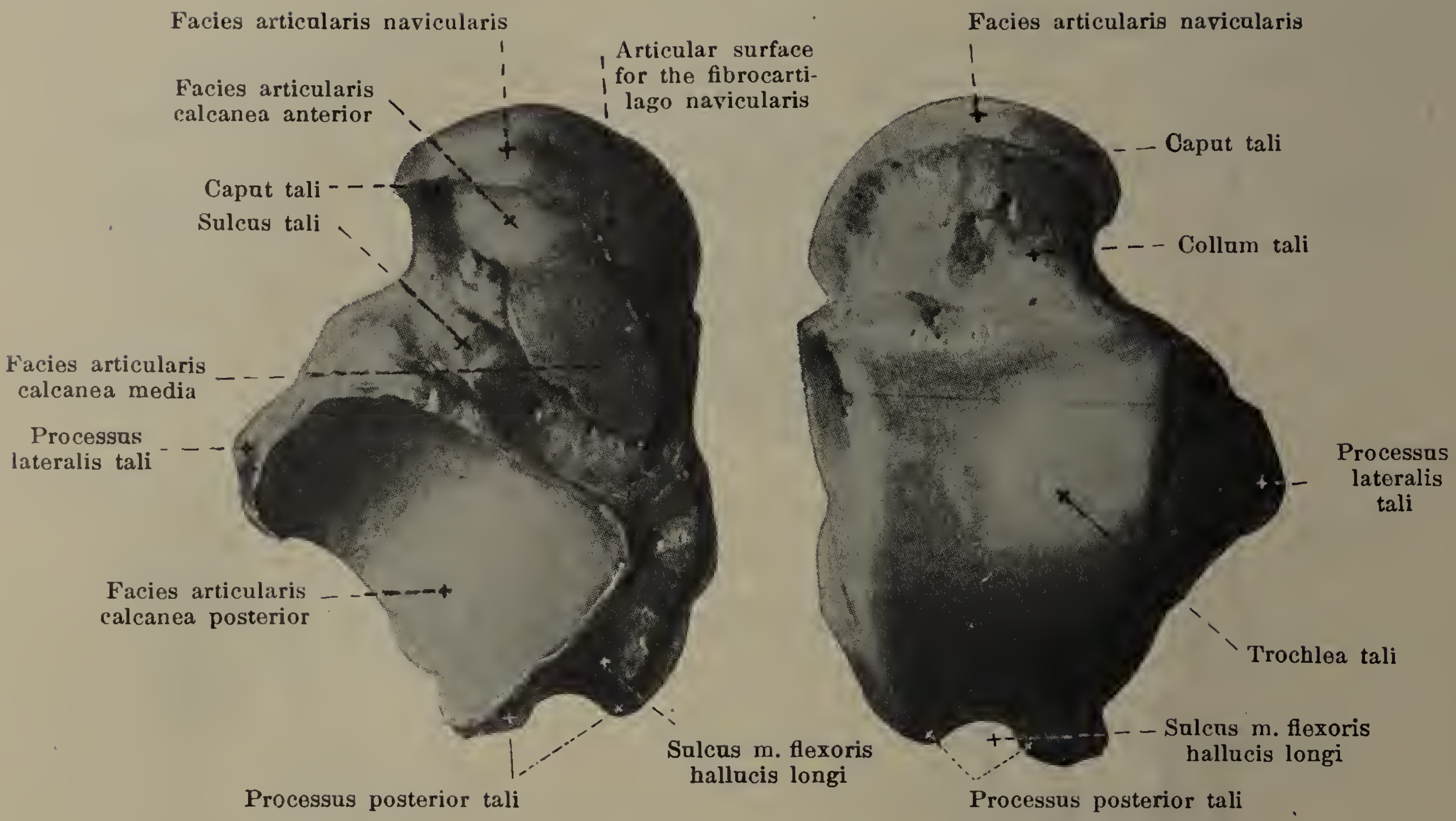
224. Right tibia and fibula, *tibia et fibula,* from above, with the places of insertion of the ligaments.


In front
Fibula
Malleolus medialis
Tibia
Malleolus lateralis
Facies articularis malleoli lateralis
Facies articularis malleoli medialis
Facies articularis inferior
Behind

225. Right tibia and fibula, *tibia et fibula,* from below.



226 and 227. Right tibia and fibula, ***tibia et fibula,***
with the muscular attachments,
from in front. from behind.


Facies articularis navicularis
Articular surface for the fibrocartilago navicularis
Facies articularis calcanea anterior
Caput tali
Sulcus tali
Facies articularis calcanea media
Processus lateralis tali
Facies articularis calcanea posterior
Sulcus m. flexoris hallucis longi
Processus posterior tali
Facies articularis navicularis
Caput tali
Collum tali
Processus lateralis tali
Trochlea tali
Sulcus m. flexoris hallucis longi
Processus posterior tali

228 and 229. Right ankle bone, *talus*,

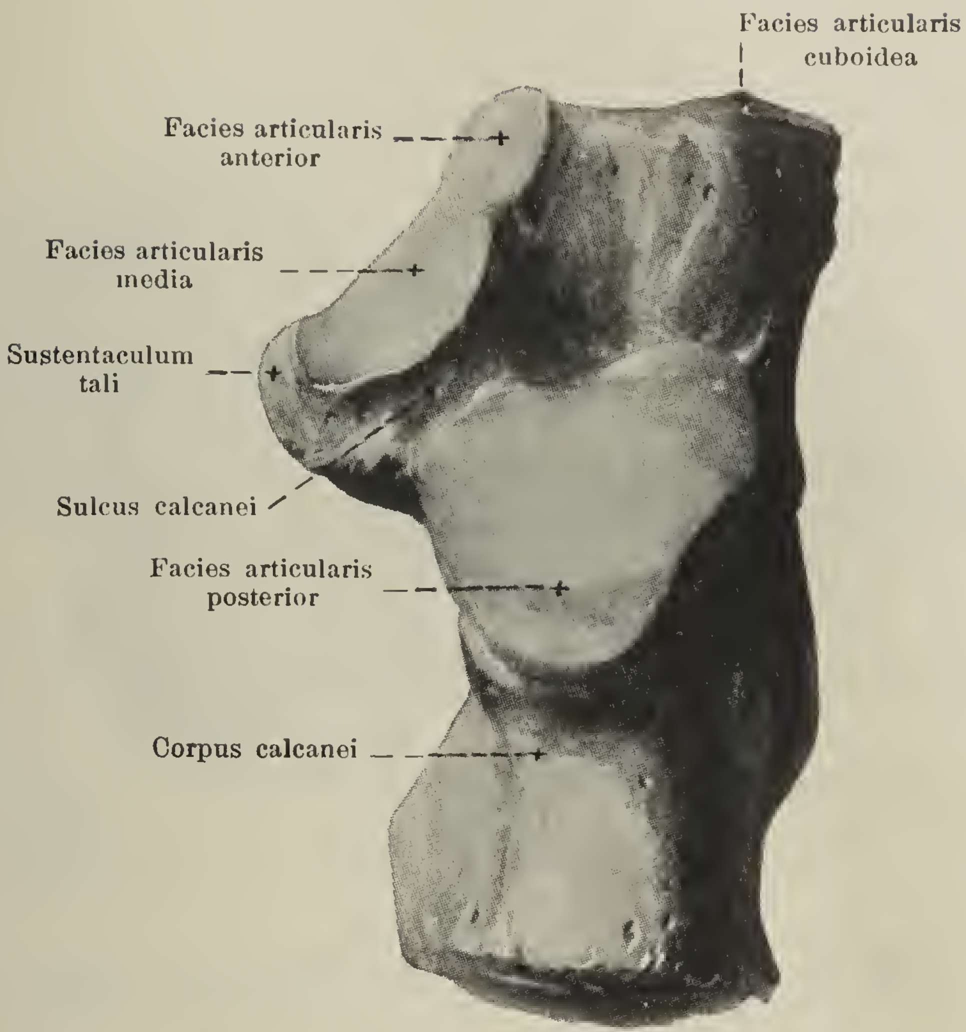
from below. from above.

The **tarsus** *(root of the foot)* (see also Figs. 240—245 and 322) is composed of the seven *ossa tarsi: talus, calcaneus, os naviculare pedis, ossa cuneiformia primum, secundum, tertium, os cuboideum;* the four last mentioned lie distalward in a row from the medial to the lateral margin of the foot close to one another; the three first mentioned proximalward partly over one another, so that the bones of the leg are not united with several bones of the tarsus, but only with that situated uppermost, namely the talus. (For development see p. 169.)

The **talus** *(ankle bone)* (O. T. astragalus) (see also Figs. 240—245) is divisible into a body, *corpus tali*, and a head, *caput tali*, attached in front; between the two lies a constricted part, the *collum tali.*

The ***corpus* tali** supports on its upper surface the broad *trochlea tali;* this is somewhat broader in front than behind, is covered with cartilage above, *facies superior*, curved so as to be markedly convex from before backward and slightly concave in transverse direction; it possesses a large, triangular, lateral surface, *facies malleolaris lateralis* (see Fig. 240), covered with cartilage, which continues on a trilateral, laterally directed process, *processus lateralis tali;* the medial surface of the trochlea has above only a narrow comma-shaped *facies malleolaris medialis* (see Fig. 241); it is covered with cartilage. The lower surface of the ankle bone possesses three articular surfaces, covered with cartilage, for the calcaneus: a posterior surface which is the largest markedly concave and cylindrical, *facies articularis calcanea posterior,* which also is continued on the processus lateralis, as well as (separated therefrom by a deep, rough groove, *sulcus tali)* two nearly flat, smaller, *facies articulares calcaneae media et anterior*, which not rarely are grown together, of which the most anterior lies upon the caput tali. On the posterior margin of the body a blunt process, *processus posterior tali,* is visible which is divided by a groove, *sulcus m. flexoris hallucis longi* (for the tendon of the m. flexor hallucis longus), into a smaller, medial and a larger, lateral projectión; the latter is sometimes an independent bone *(os trigonum)* and then is connected by connective tissue only with the remaining bone (it is not shown in the figure).

The ***head*** presents in front an oval, transversely directed, markedly convex articular surface, *facies articularis navicularis* (for the os naviculare); adjacent to this, below and medianward, is another oblong surface for the lig. calcaneonaviculare plantare resp. the fibrocartilago navicularis.

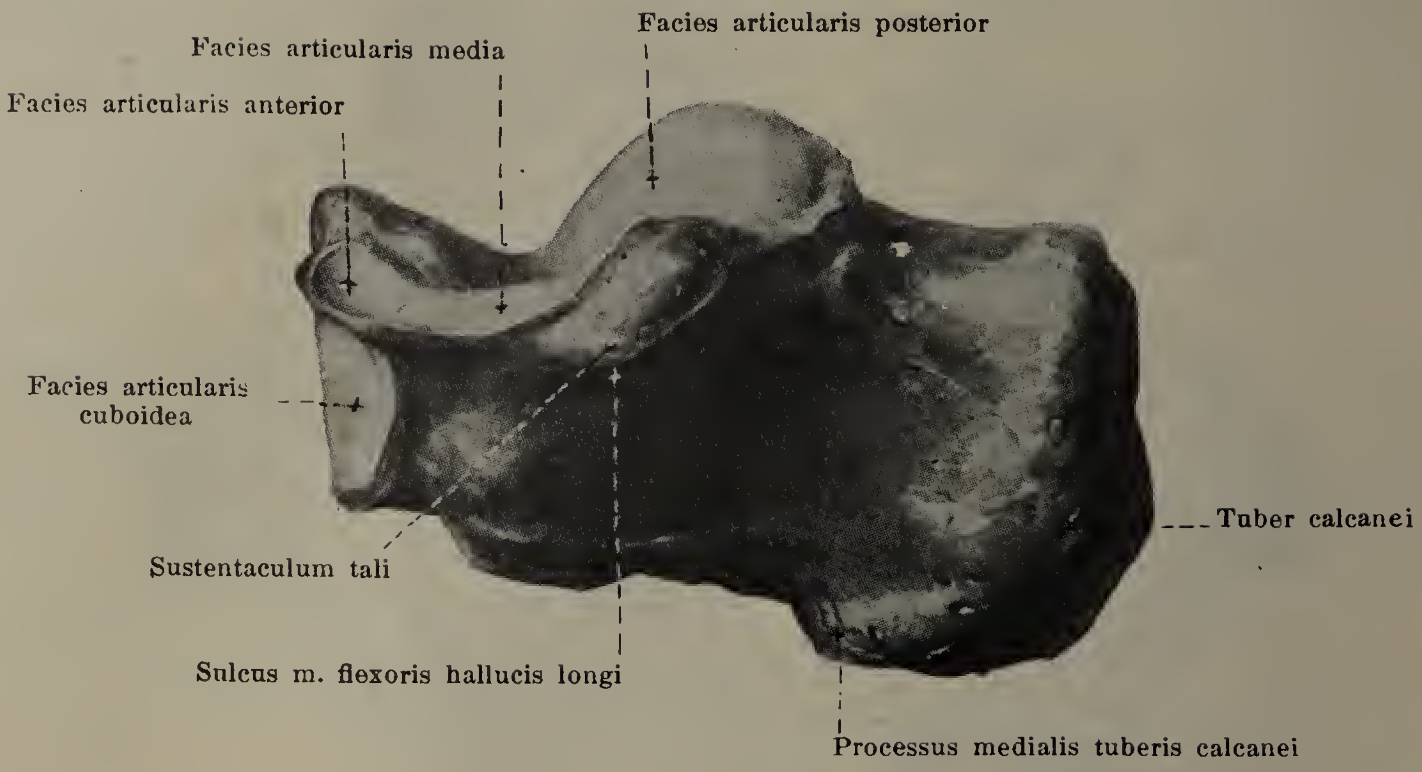

Facies articularis cuboidea
Facies articularis anterior
Facies articularis media
Sustentaculum tali
Sulcus calcanei
Facies articularis posterior
Corpus calcanei

230. Right heel bone, *calcaneus,* from above.

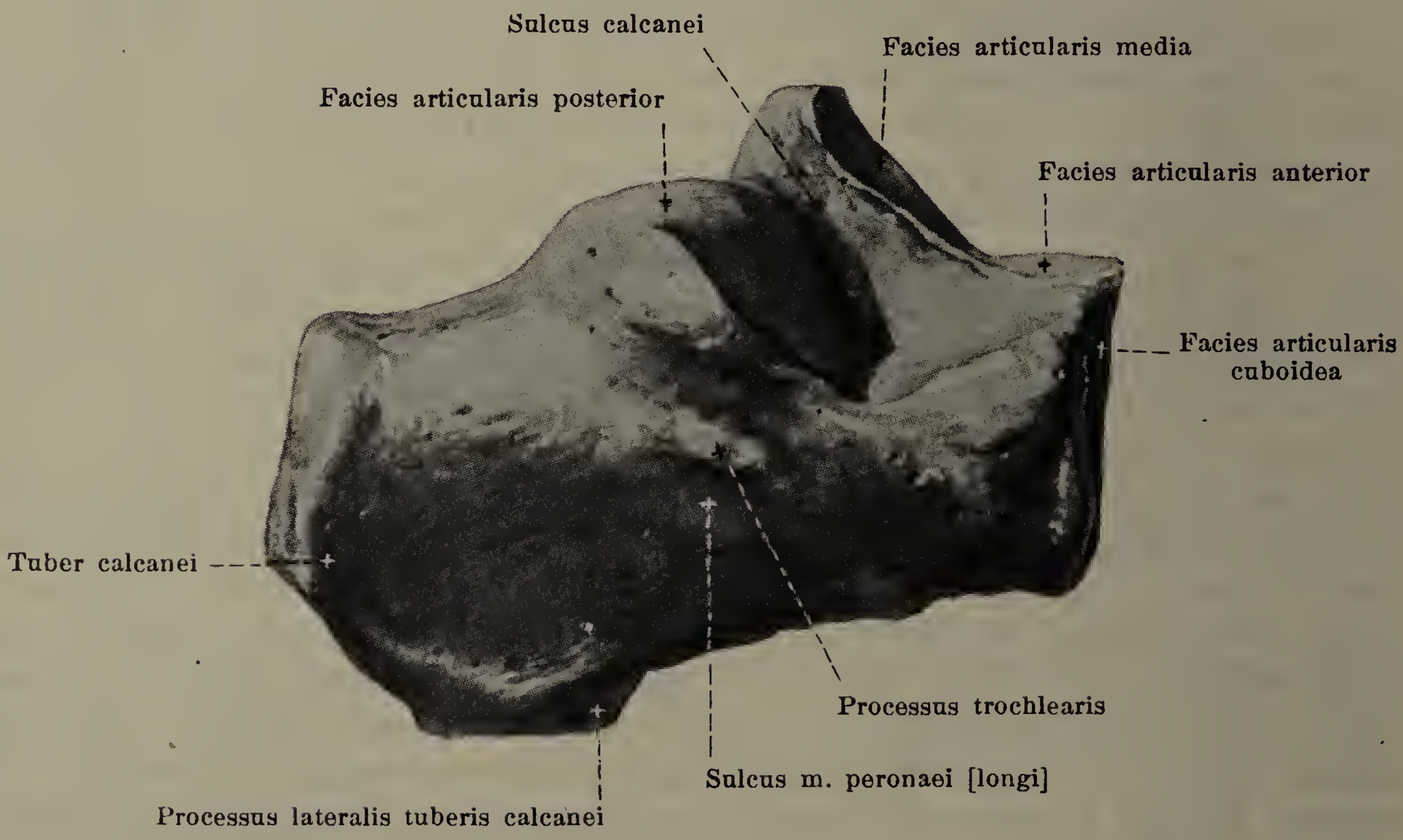
The **calcaneus** *(heel bone,* O. T. os calcis) (see also Figs. 231, 232, 240—245) is the largest tarsal bone, lies below the ankle bone and at the same time projects beyond it behind. It possesses a quadrilaterally prismatic body, *corpus calcanei,* and an anterior extremity which are not separated sharply.

The corpus calcanei becomes thickened behind to form the *tuber calcanei,* from which two rough broad projections pass downward, the *processus medialis tuberis calcanei,* and the *processus lateralis tuberis calcanei* (see Fig. 243). The posterior surface of the tuber is smooth in its upper part and is there separated by the bursa tendinis calcanei [Achillis], from the tendo calcaneus [Achillis]; the rough oval below this smooth surface serves as a place of attachment for the tendo Achillis. The upper surface has three articular surfaces covered with cartilage for the talus: about in its middle an oblong, markedly convex, cylindrical, *facies articularis posterior,* in front and medianward two smaller, almost flat, *facies articulares media et anterior,* which are not seldom grown together, the latter are separated from the posterior by a rough deep groove, *sulcus calcanei;* the middle rests upon a medially projecting, long piece of bone, *sustentaculum tali,* which presents on its inferior surface a groove, the *sulcus m. flexoris hallucis longi* (for the tendon of the m. flexor hallucis longus). The margin of this projection directed medianward is usually rough, sometimes, however, partly smooth or hollowed out like a groove; on it glides the tendon of the m. flexor digitorum longus on its way to the sole of the foot. On the lateral surface of the heel bone there is often a small projection, *processus trochlearis,* below which runs a groove, the *sulcus m. peronaei [longi]* (for the tendon of the m. peronaeus longus). The anterior surface of the calcaneus is directed also medianward, is quadrangular with rounded corners, curved so as to be saddle-shaped and covered with cartilage to form the *facies articularis cuboidea* (for the os cuboideum).

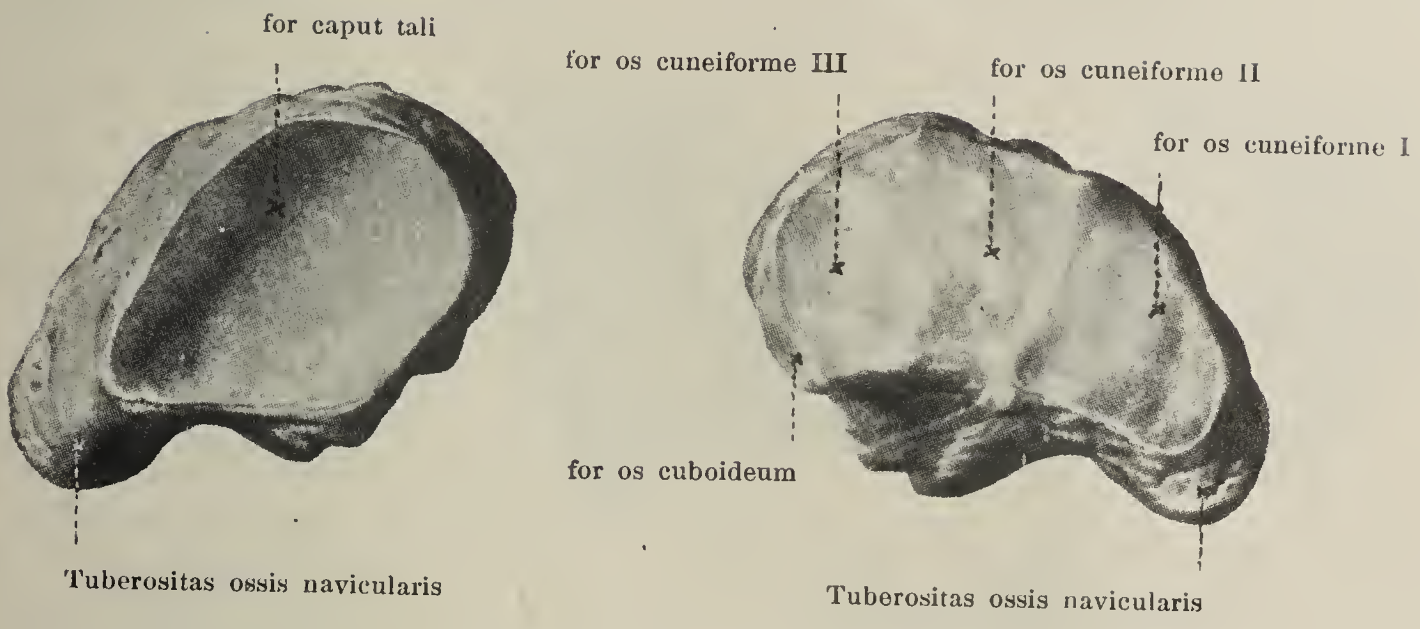
The sulcus calcanei and sulcus tali form together the *sinus tarsi,* a canal which, open lateralward, grows markedly narrower as it extends medianward.


Facies articularis media
Facies articularis posterior
Facies articularis anterior
Facies articularis cuboidea
Sustentaculum tali
Tuber calcanei
Sulcus m. flexoris hallucis longi
Processus medialis tuberis calcanei

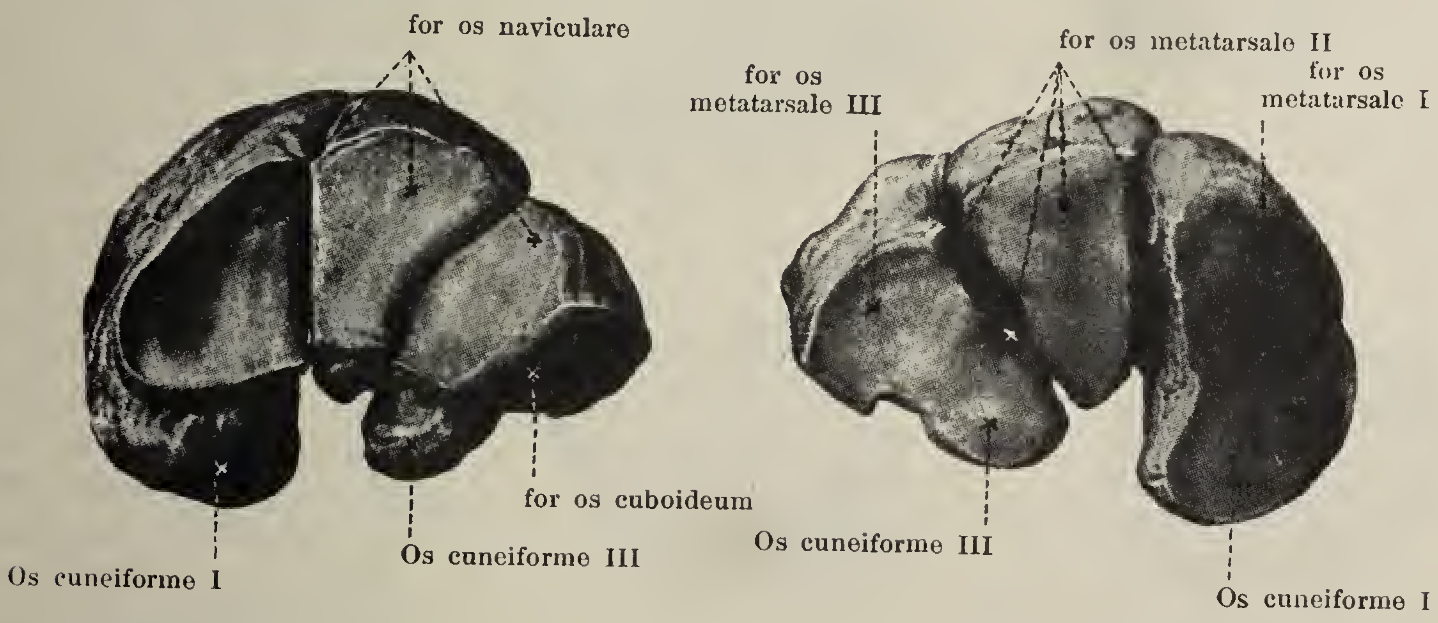
231. Right heel bone, ***calcaneus,*** from within.


Sulcus calcanei
Facies articularis media
Facies articularis posterior
Facies articularis anterior
Facies articularis cuboidea
Tuber calcanei
Processus trochlearis
Sulcus m. peronaei [longi]
Processus lateralis tuberis calcanei

232. Right heel bone, ***calcaneus,*** from without and somewhat from above.



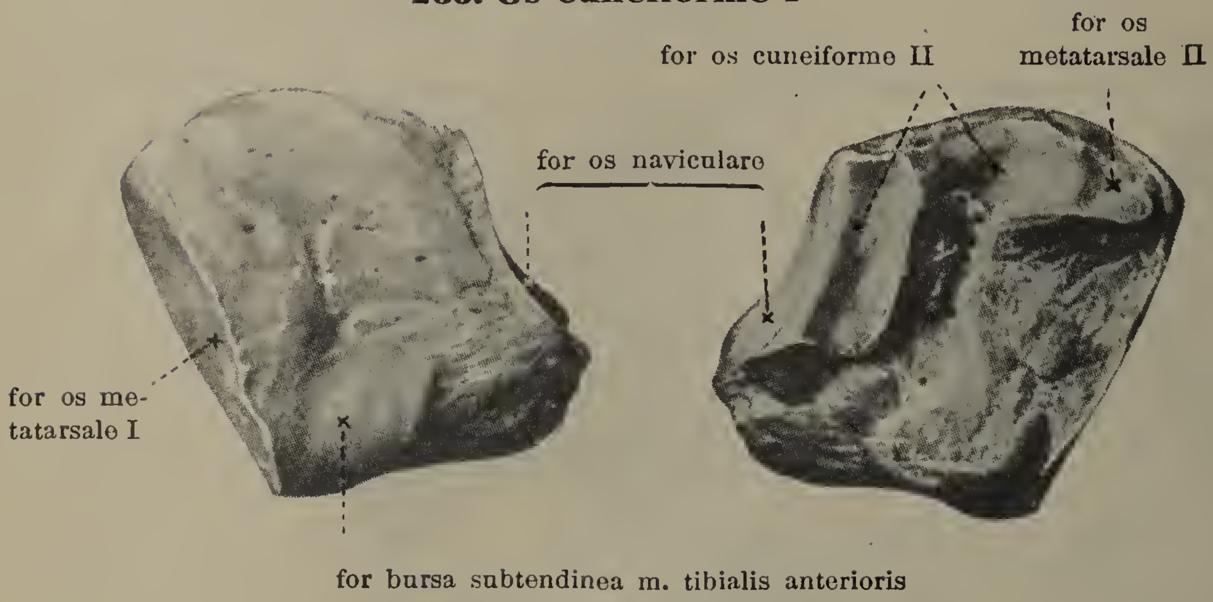
233. Right scaphoid bone, *os naviculare pedis,*
from behind. from in front.



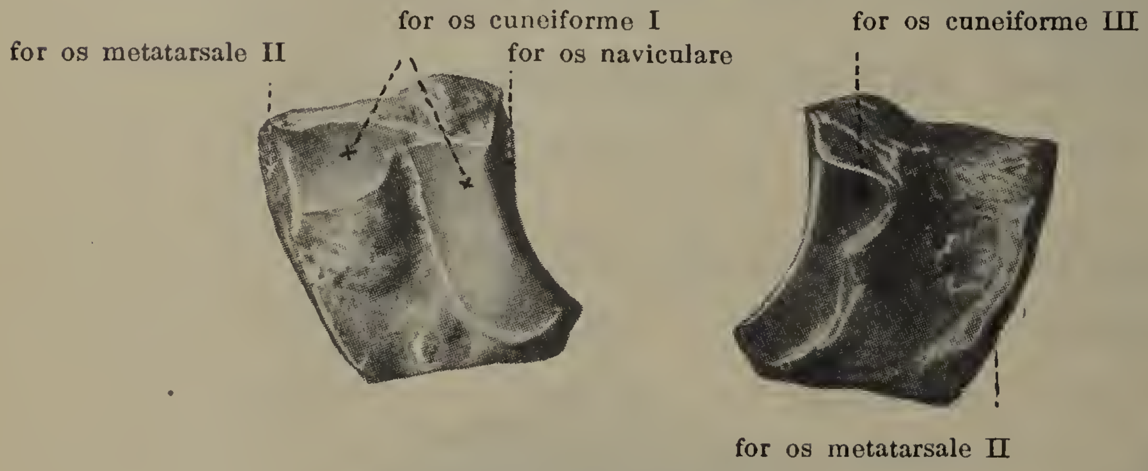
234. The cuneiform bones of the right,
ossa cuneiformia,
from behind. from in front.

The **os naviculare pedis** *(scaphoid bone)* (see also Figs. 240—245 and 322) is oval, flattened from before backward and lies in front of the talus on the medial side of the tarsus. Its longest axis points in an oblique direction from lateral-dorsal towards medial-plantar. It possesses proximally a markedly concave articular surface covered with cartilage for the caput tali, distalward a convex surface covered with cartilage and divided by two ridges into three parts for the three cuneiform bones. The lateral surface supports, usually, a small articular surface for the os cuboideum (see Fig. 322). The upper surface is rough, convex and slopes markedly toward the medial side. Medianward on the lower surface the broad rough *tuberositas ossis navicularis* projects downward.

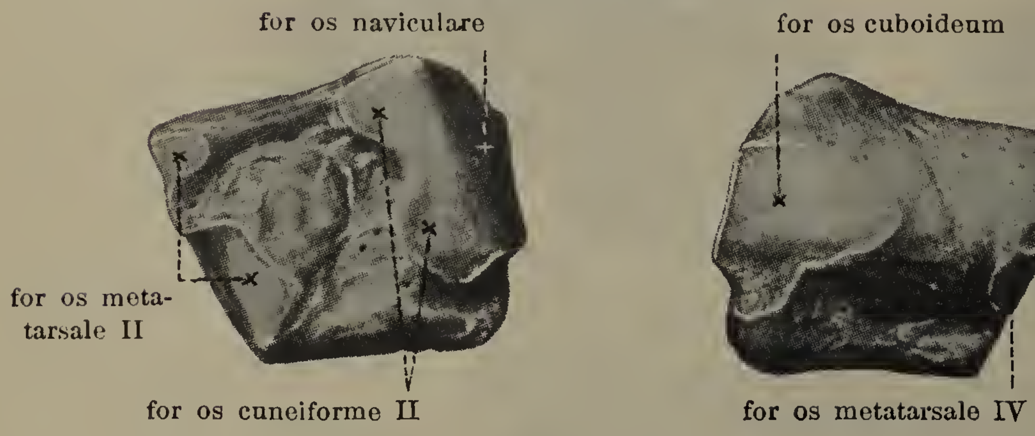
235. Os cuneiforme I



236. Os cuneiforme II



237. Os cuneiforme III



235—237. The cuneiform bones of the right, *ossa cuneiformia,* single,

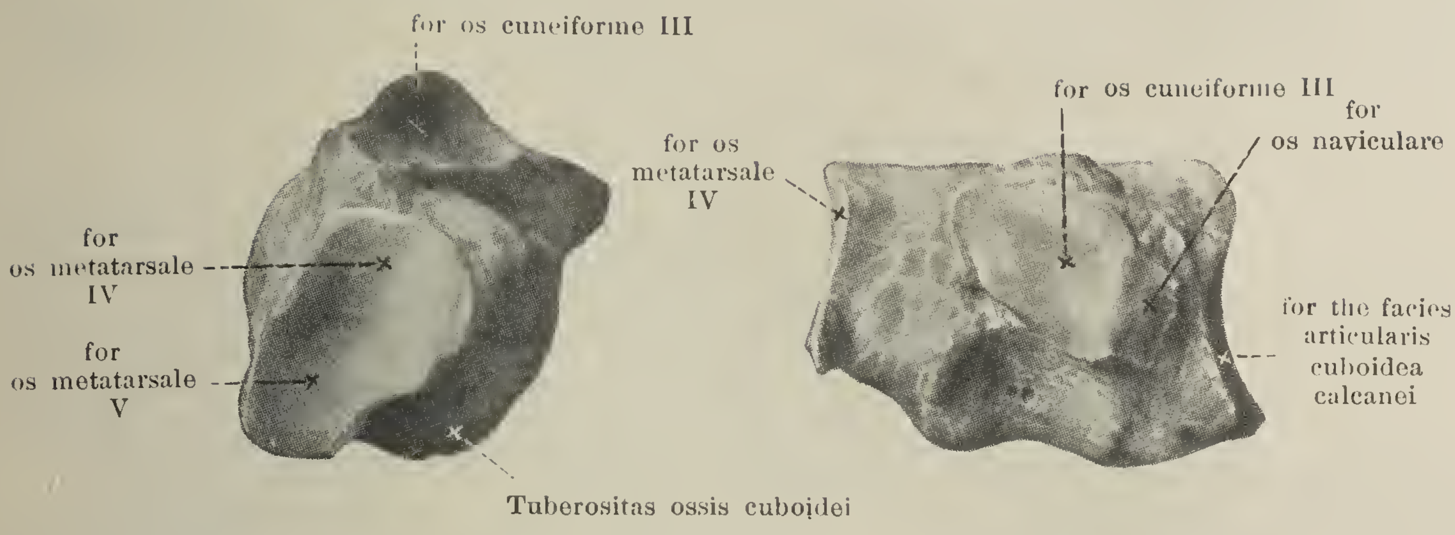
from within. from without.

The **ossa cuneiformia primum, secundum, tertium** *(wedge bones)* (see also Figs. 234, 240—245 and 322) are wedge-shaped; they lie distally from the os naviculare and are numbered beginning at the medial border of the foot.

The **os cuneiforme primum** (O. T. internal cuneiform bone) is the largest with the base of the wedge directed plantarward; it is curved slightly lateralward at its upper extremity. The posterior surface is triangularly rounded, flat and covered with cartilage (for the os naviculare). The medial surface, turned also upward, is rough and possesses in front and below an oblique flat groove in which lies the tendon of the m. tibialis anterior, being very often separated from the bone by the bursa subtendinea m. tibialis anterioris. The anterior surface is slightly convex, covered with cartilage, bean-shaped (for the os metatarsale I); the lateral surface has an anterior, small articular surface (for the os metatarsale II) and a larger, divided (for the os cuneiforme II).

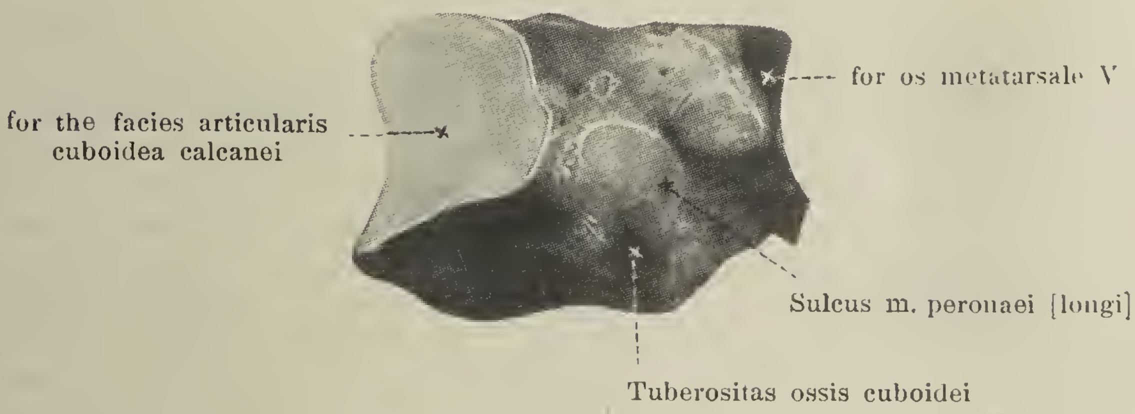
The **os cuneiforme secundum** is the smallest with the base of the wedge directed dorsalward. The posterior, quadrangular, slightly concave surface, covered with cartilage, serves for the attachment of the os naviculare, the anterior, triangular surface, covered with cartilage, for the os metatarsale II; on the medial side is a divided joint surface for the os cuneiforme I, on the lateral side proximally a plain one for the os cuneiforme III.

The **os cuneiforme tertium** has the base of the wedge looking dorsalward. Its posterior, quadrangular-rounded surface, covered with cartilage, is attached to the os naviculare, the anterior, triangular surface covered with cartilage to the os metatarsale III; medianward it possesses a small, anterior articular surface for the os metatarsale II and a larger, posterior for the os cuneiforme II; lateralward it supports a small, anterior articular surface for the os metatarsale IV and a larger, posterior for the os cuboideum.



From in front

From the inner side


for the facies articularis cuboidea calcanei
for os metatarsale V
Sulcus m. peronaei [longi]
Tuberositas ossis cuboidei

From below

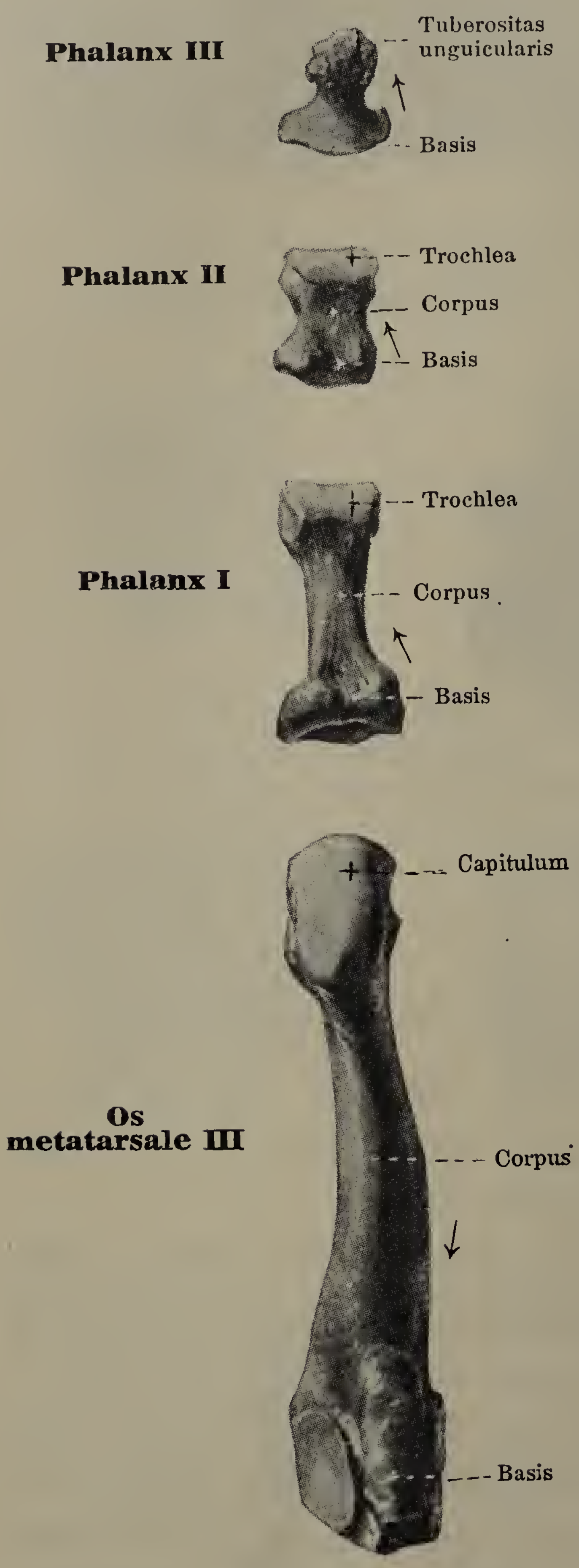
238. Right cuboid bone, *os cuboideum.*

The **os cuboideum** *(cuboid bone)* (see also Figs. 240—245 and 322) is very irregularly cuboid in shape and lies in front of the calcaneus and on the lateral side of the tarsus. Is it longer medianward than lateralward.

Its posterior surface, covered with cartilage, is directed also lateralward, is quadrangularly rounded, curved so as to be saddle-shaped (for the facies articularis cuboidea calcanei); its distal surface supports two rounded quadrangular articular surfaces (for the ossa metatarsalia IV et V) separated by a slight ridge; its medial surface shows a larger articular surface for the os cuneiforme III and usually also proximally a smaller one for the os naviculare (see Fig. 322). The upper, lateral surface is rough. The lower surface presents an oblong bulging, the *tuberositas ossis cuboidei,* above the anterior smooth portion of which, covered lateralward with cartilage *(sulcus m. peronaei [longi]),* the tendon of the m. peronaeus longus glides. In front of the tuberosity is a rough groove extending obliquely medianward and forward.

239. Metatarsal bone and phalanges of the third toe of the right side, *os metatarsale III et phalanges digiti tertii,* from the plantar aspect.

(The arrows indicate the direction of the canales nutricii.)



The five **ossa metatarsalia** *(metatarsal bones)* (see also Figs. 240—245) are short cylindrical bones in which can be distinguished a shaft or *corpus*, a proximal end, *basis*, and a distal end, *capitulum*. On the whole they are curved so as to be somewhat convex dorsalward. (For the development see p. 169.) The os metatarsale I is shorter and thicker than the others.

The ***corpus*** is triangularly prismatic so that one side looks dorsalward, the other two lateral- and medianward; the latter meet in a border directed plantarward. A *foramen nutricium* situated on the plantar side leads like in the hand at the first metatarsal bone in a distally directed, at the 2nd to 5th in a proximally directed *canalis nutricius.*

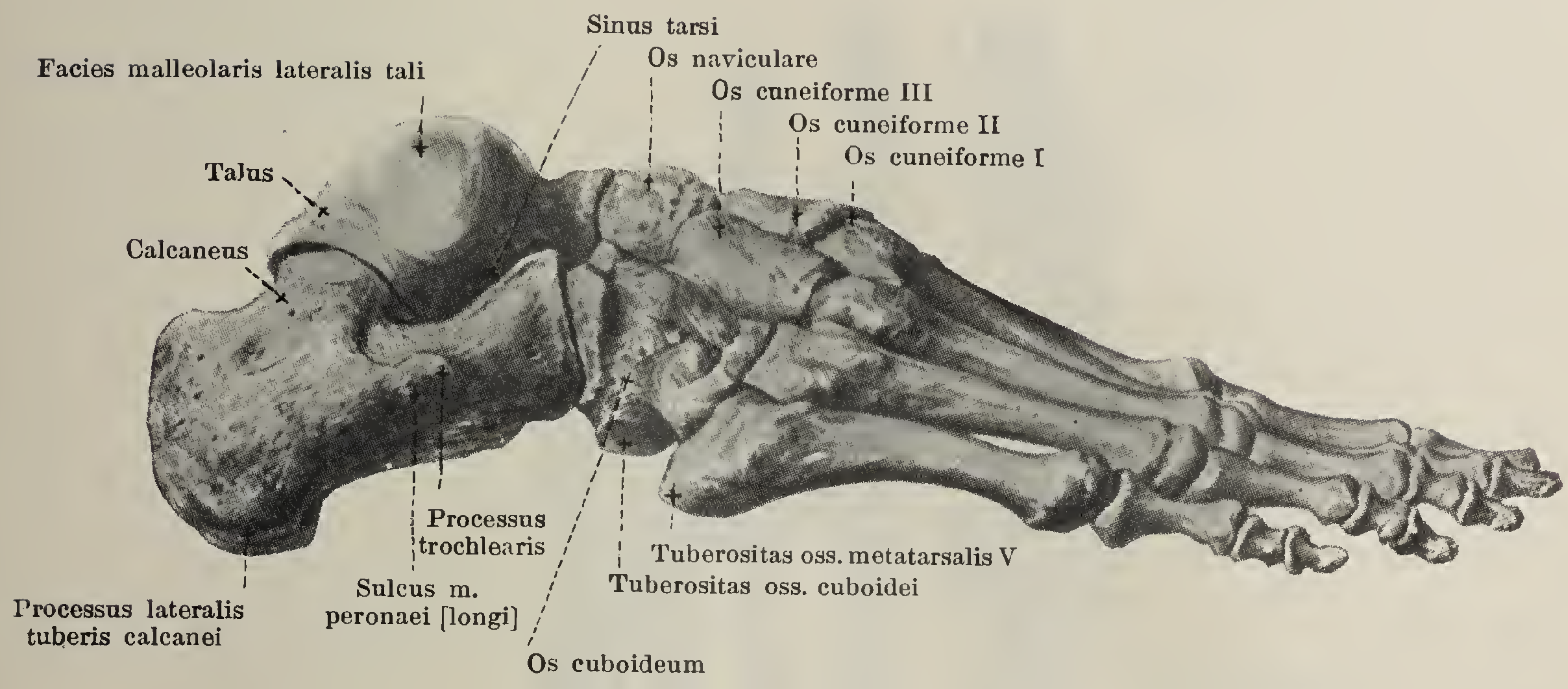
The ***basis*** (see also Fig. 322) is usually somewhat broadened, supports on its proximal side an articular surface for connection with the tarsus and from the second to the fifth toe also small articular surfaces at the sides for the neighboring metatarsal bones as well as on the second and fourth toes also for tarsal bones. The basis ossis metatarsalis I possesses proximally a large concave, bean-shaped articular surface (for the os cuneiforme I), and frequently a small articular surface on the lateral side; on the plantar surface a blunt nodule, ***tuberositas ossis metatarsalis I*** (for the insertion of the m. peronaeus longus), projects lateralward (see Fig. 243). Projecting from the side of the basis ossis metacarpalis V backward is a strong process, the ***tuberositas ossis metatarsalis V***, for the insertion of the mm. peronaeus brevis and abductor digiti V (see Figgs. 240, 242 and 243).

The ***capitulum*** is flattened laterally and possesses a spherical articular surface, covered with cartilage, which extends further upon the plantar than upon the dorsal surface. At the sides are rough areas for the articular ligaments.

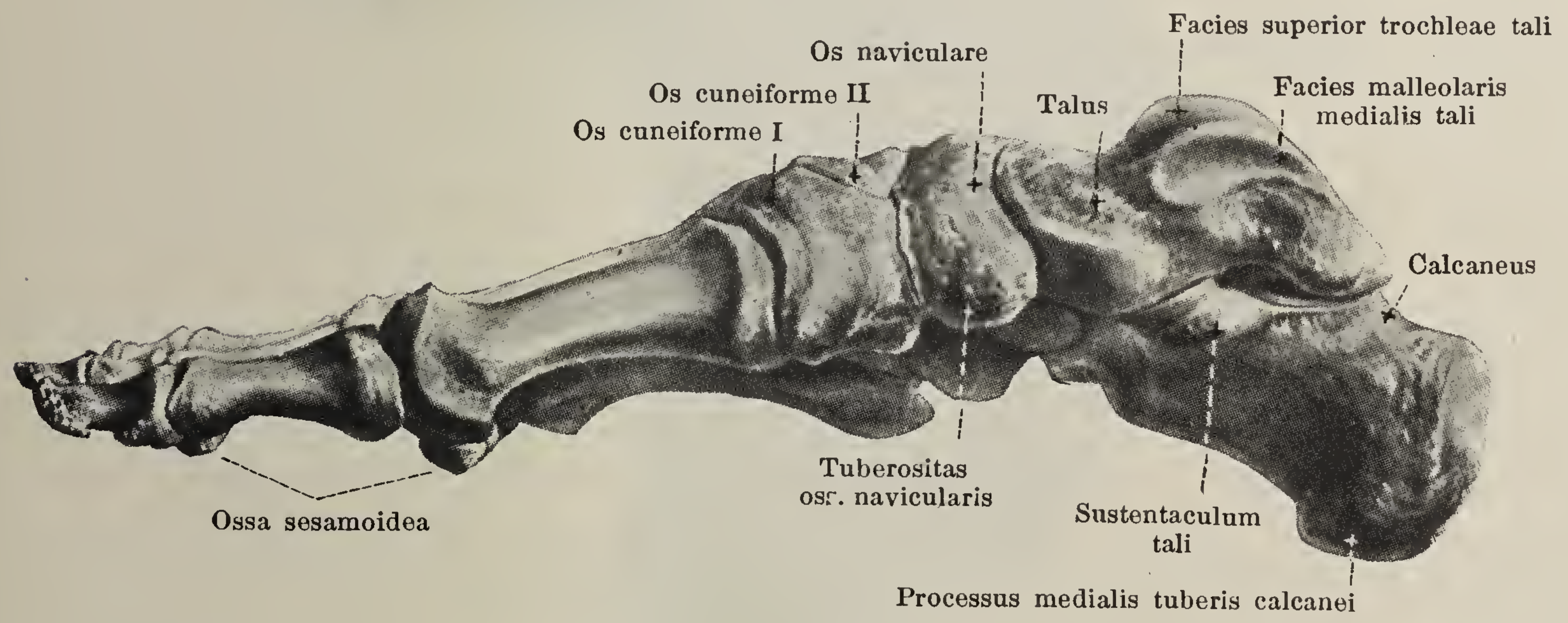
The four spaces between the ossa metatarsalia, ***spatia interossea metatarsi*** (see Figs. 242 and 243), correspond to the spatia interossea metacarpi (see p. 121).

The **phalanges digitorum** correspond in number, arrangement and form as well as in the relations of their foramina nutricia entirely to those of the hand (see p. 121), except that they are all essentially shorter, especially the second and third. The 2nd and 3rd phalanx of the 5th toe are often ankylosed. (For the development see p. 169.)

As to **ossa sesamoidea** *(sesamoid bones)* (see Fig. 243), two are constantly found at the metatarsophalangeal joint of the great toe, a third less constant, at the interphalangeal joint of the same toe; a fourth is situated in the tendon of the m. peronaeus longus in front of the lateral angle of the tuberositas ossis cuboidei and a fifth sometimes in the tendon of the m. tibialis posterior below the fibrocartilago navicularis. (For the development see p. 169.)

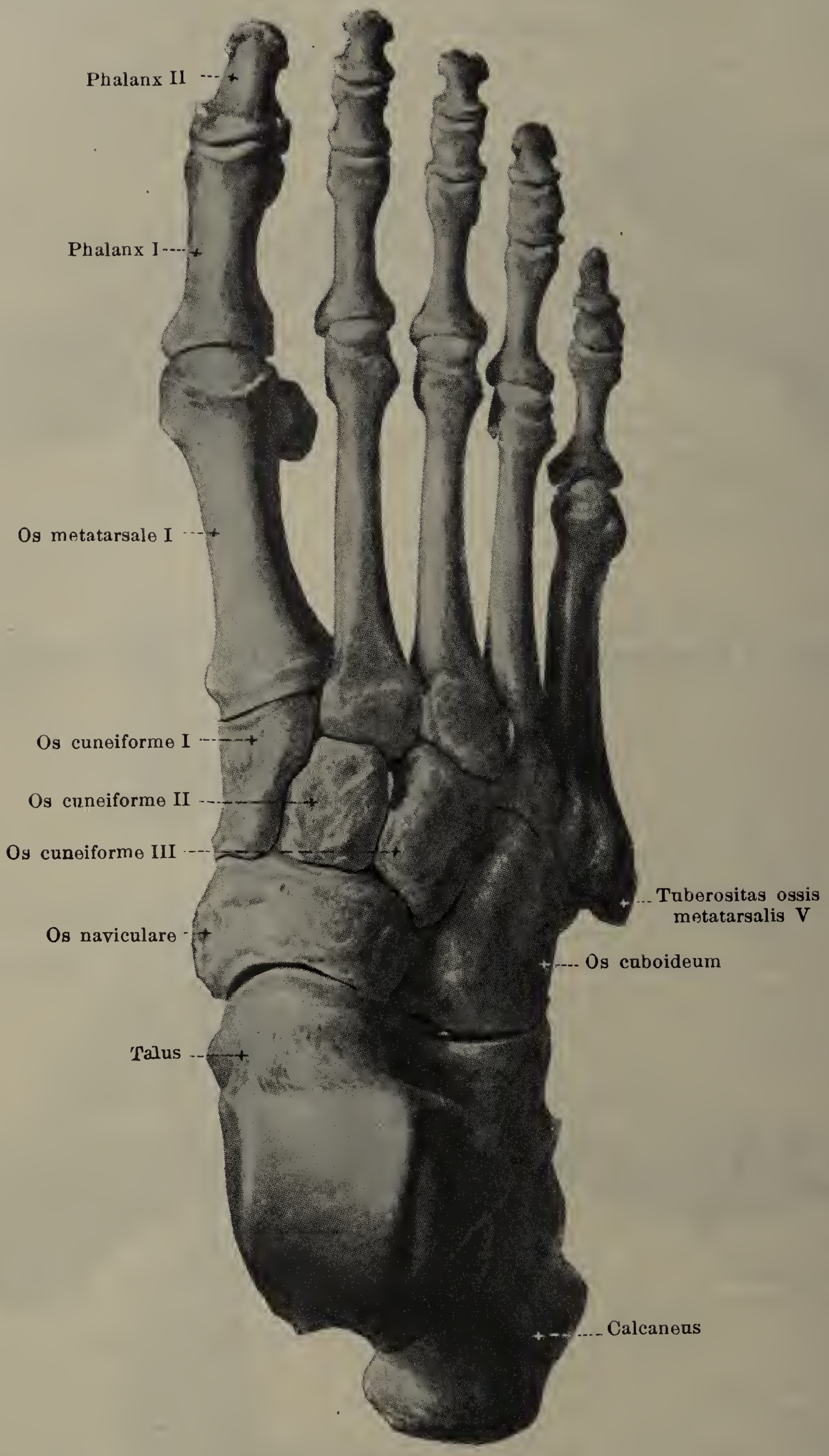

Sinus tarsi
Facies malleolaris lateralis tali
Os naviculare
Os cuneiforme III
Os cuneiforme II
Os cuneiforme I
Talus
Calcaneus
Processus trochlearis
Tuberositas oss. metatarsalis V
Tuberositas oss. cuboidei
Processus lateralis tuberis calcanei
Sulcus m. peronaei [longi]
Os cuboideum

240. Bones of the right foot, ***ossa pedis,***
from the lateral aspect.


Facies superior trochleae tali
Os naviculare
Facies malleolaris medialis tali
Os cuneiforme II
Talus
Os cuneiforme I
Calcaneus
Tuberositas oss. navicularis
Ossa sesamoidea
Sustentaculum tali
Processus medialis tuberis calcanei

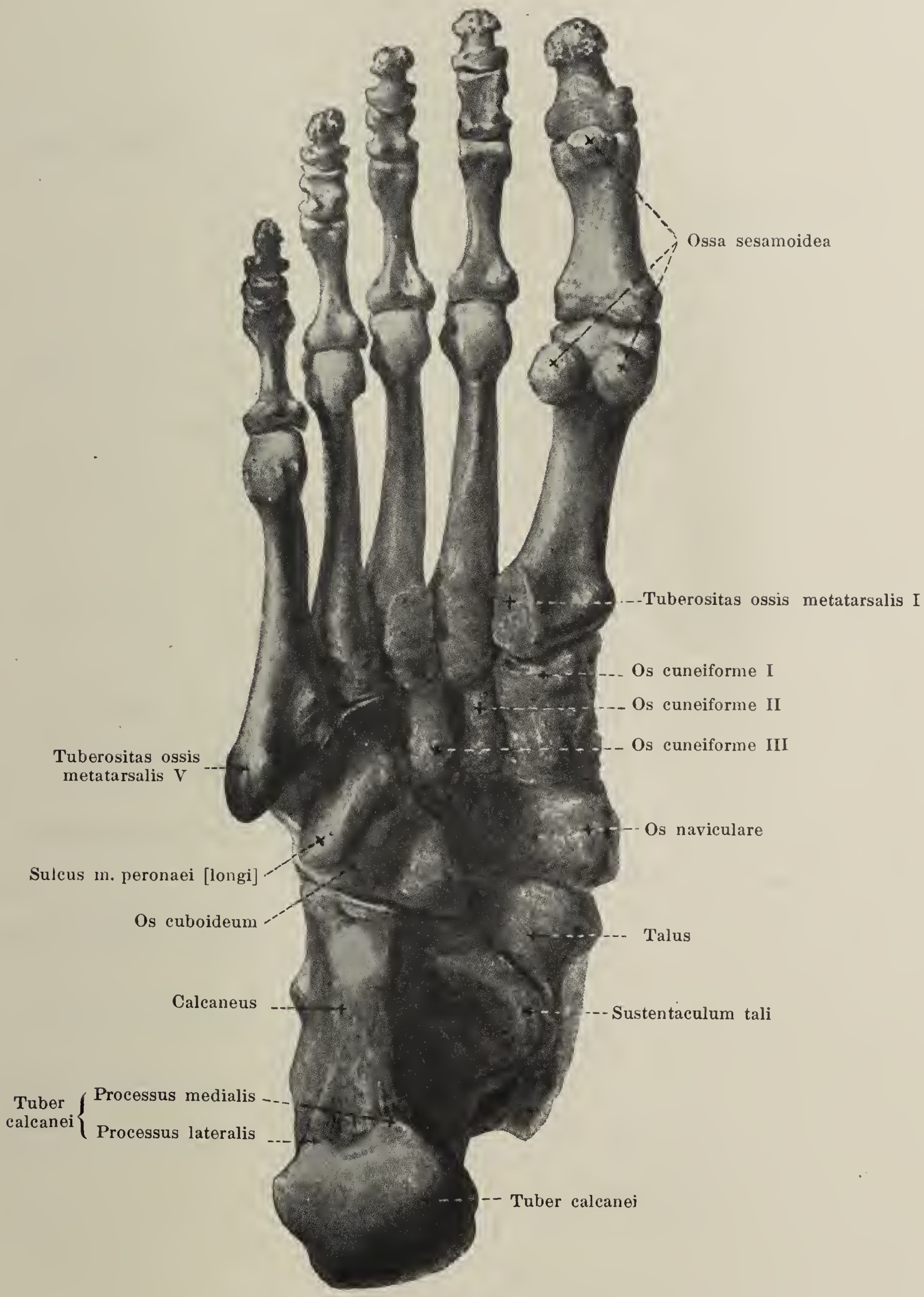
241. Bones of the right foot, ***ossa pedis,***
from the medial aspect.

In the figures 240—245 the position of the phalanges, especially at the 2nd to the 5th toe, does not correspond exactly to the real one.



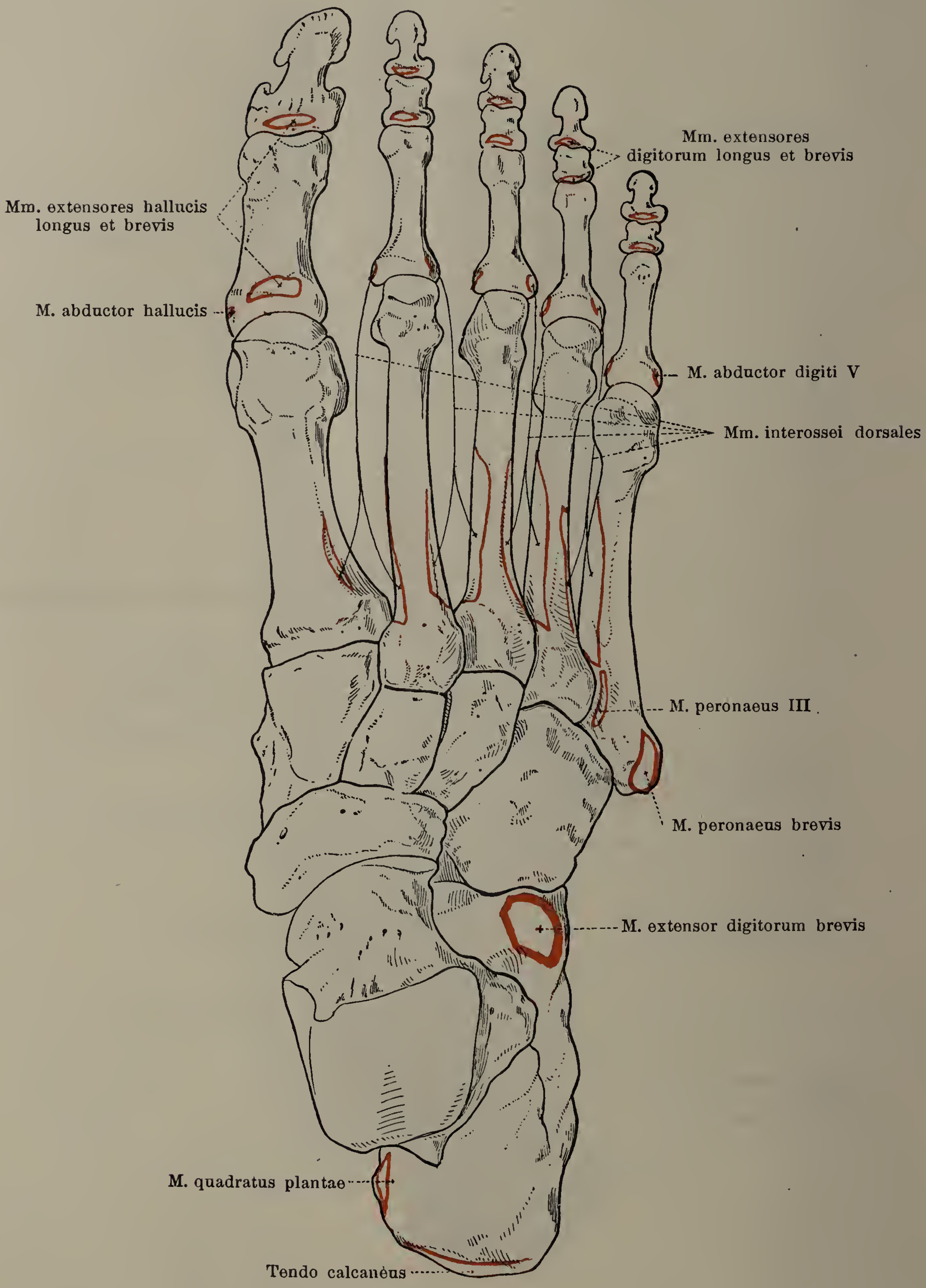
242. Bones of the right foot, ***ossa pedis,***
viewed from the back of the foot.

In the figures 240—245 the position of the phalanges, especially at the 2nd to the 5th toe, does not correspond exactly to the real one.



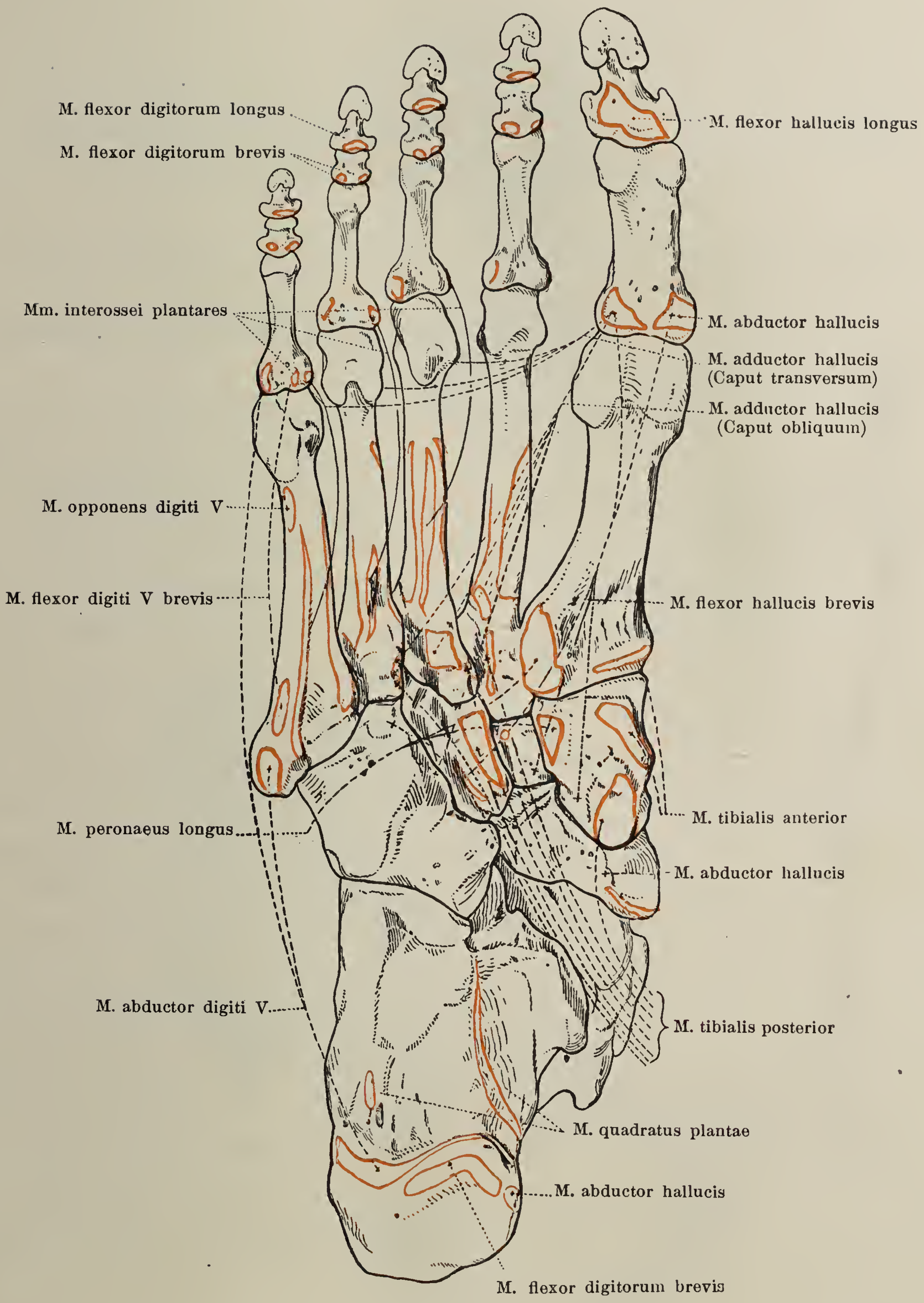
243. Bones of the right foot, ***ossa pedis,***
viewed from the sole of the foot.

In the figures 240—245 the position of the phalanges, especially at the 2nd to the 5th toe, does not correspond exactly to the real one.



244. Bones of the right foot, *ossa pedis*, with the muscular attachments, viewed from the back of the foot.

In the figures 240—245 the position of the phalanges, especially at the 2nd to the 5th toe, does not correspond exactly to the real one.


M. flexor digitorum longus
M. flexor digitorum brevis
M. flexor hallucis longus
Mm. interossei plantares
M. abductor hallucis
M. adductor hallucis (Caput transversum)
M. adductor hallucis (Caput obliquum)
M. opponens digiti V
M. flexor digiti V brevis
M. flexor hallucis brevis
M. tibialis anterior
M. peronaeus longus
M. abductor hallucis
M. abductor digiti V
M. tibialis posterior
M. quadratus plantae
M. abductor hallucis
M. flexor digitorum brevis

245. Bones of the right foot, *ossa pedis,*

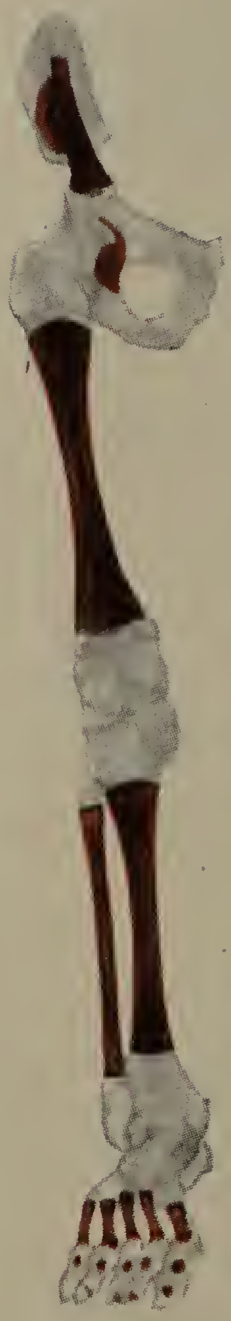
with the muscular attachments, viewed from the sole of the foot.

In the figures 240—245 the position of the phalanges, especially at the 2nd to the 5th toe, does not correspond exactly to the real one.

246. Skeleton of the right lower extremity of a 5 month fetus, from in front.

Magnif.: 1 : 1.

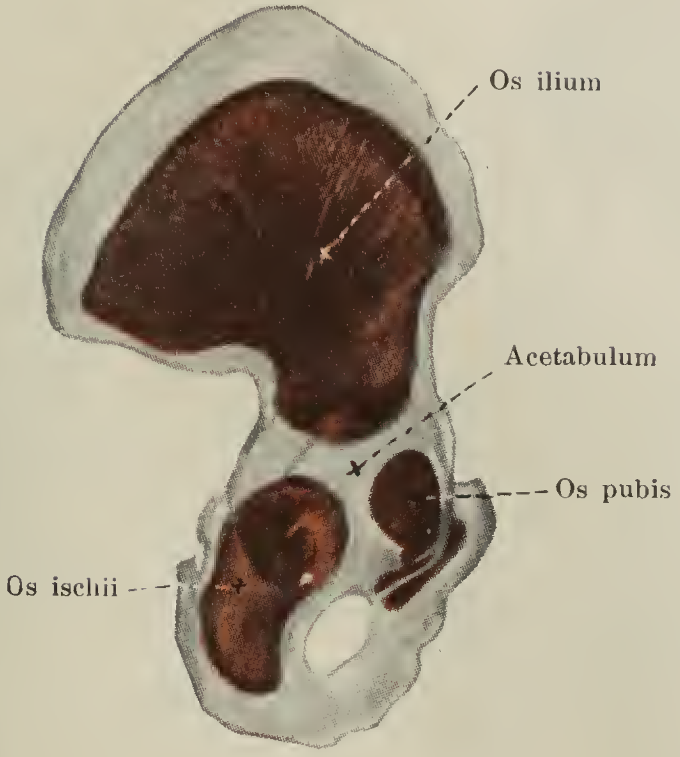
(The bone substance is colored red, the rest of the skeleton is made transparent.)



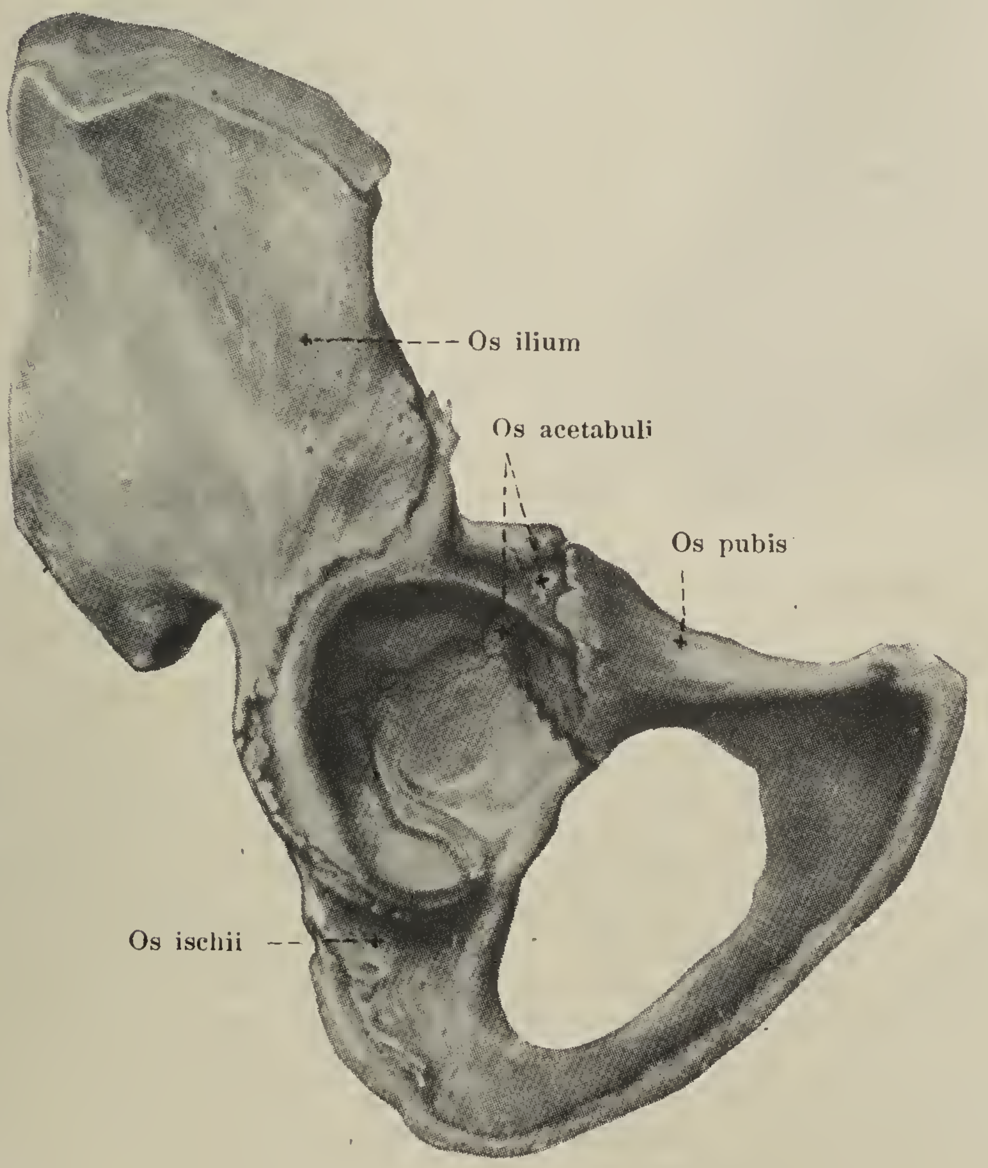
Development of the bones of the lower extremities.

They are all preformed in cartilage.

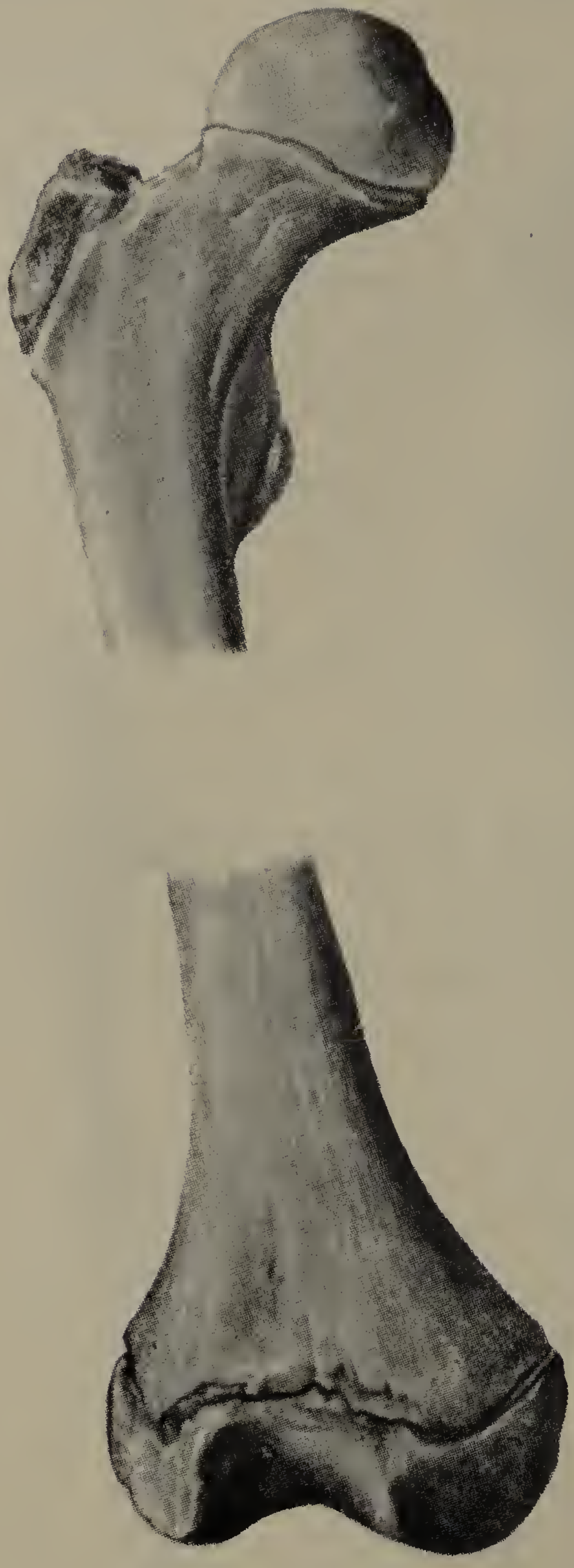
The ***os coxae*** (see also Figs. 130—132, 247 and 248). It develops from three chief parts: in the os ilium the nucleus appears in the 8th week, in the os ischii in the 4th month, in the os pubis in the 4th — 5th month. These three nuclei form the acetabulum and are there separated from each other until the time of puberty by a Y-shaped cartilage. In this cartilage there appears in the 9th—12th year a nucleus between the os ilium and os pubis which forms the *os acetabuli* of variable size, and furthermore there appear after puberty also some smaller epiphyseal nuclei; the os acetabuli unites about the time of puberty with the os pubis. The rami inferiores of the os pubis and os ischii grow together between the 7th and 8th year; the three main parts unite with each other and with the small nuclei at the bottom of the acetabulum about the 20th year. Soon after puberty epiphyseal nuclei appear: 1st along the crista iliaca (union between 20th and 25th year), 2nd at the tuber ischiadicum (union between 17th and 24th year), 3rd at the spina ischiadica (union between the 18th and 20th year), and 4th at the spina iliaca anterior inferior (union between the 18th and 20th year. In the 18th—20th year there appears at the facies symphyseos oss. pubis an epiphysis with one or two nuclei (union after the 20th year).



247. Right hip bone of an 8 month fetus,
viewed from outside. Magnif.: 1:1.
(The bone substance is colored red, the rest of the ilium is made transparent.)

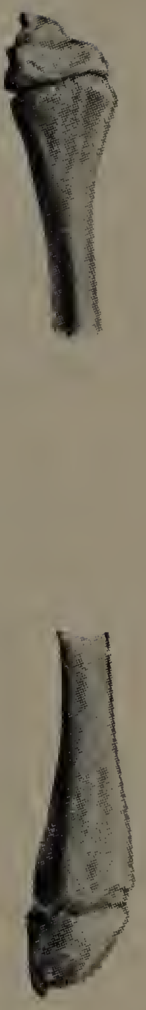


248. Right hip bone of a 10 year old girl,
from the front and below. Magnif.: 1:2.



249. Femur.

250. Tibia.



251. Fibula.

249—251. Bones of the right lower extremity of a 10 year old girl, from in front. Magnif.: 1:2.

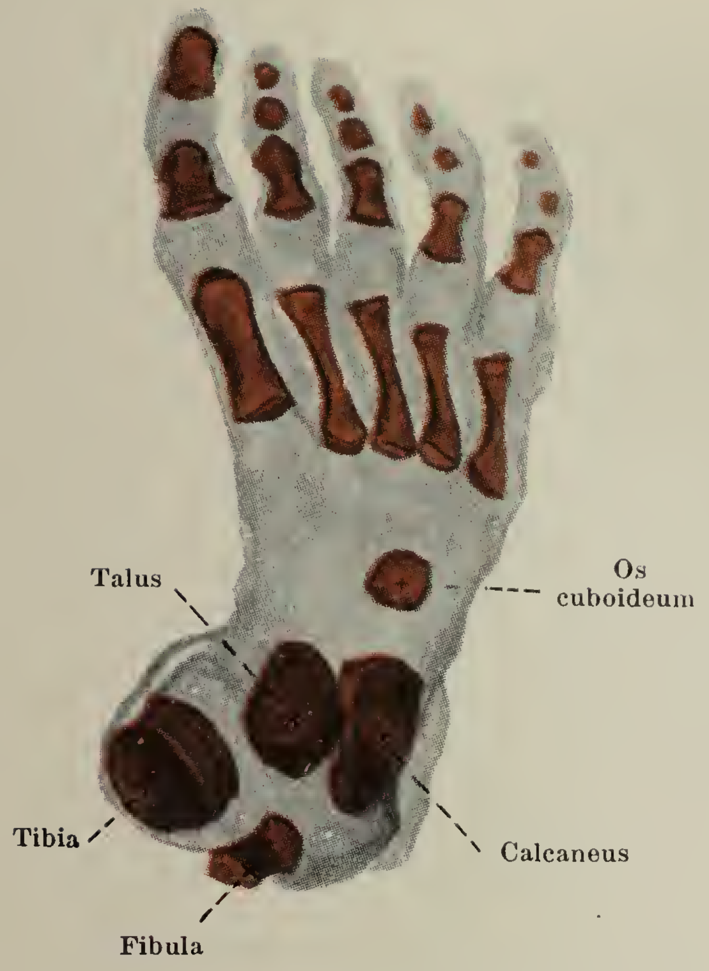
(Only the proximal and distal portions are drawn.)

Femur (see also Fig. 246). The nucleus for the diaphysis appears on the 42nd day. The distal epiphysis receives its nucleus for the most part shortly before birth and unites with the shaft in the 20th—24th year. At the proximal end there appear three epiphyseal nuclei: one for the caput in the 1st year (union in the 18th—19th year), one (sometimes several) for the trochanter major in the 3rd—4th year (union in the 18th year), and still another one for the trochanter minor in the 11th—14th year (union in the 17th year).

The ***Patella*** acquires its centre of ossification in the 3rd—5th year.

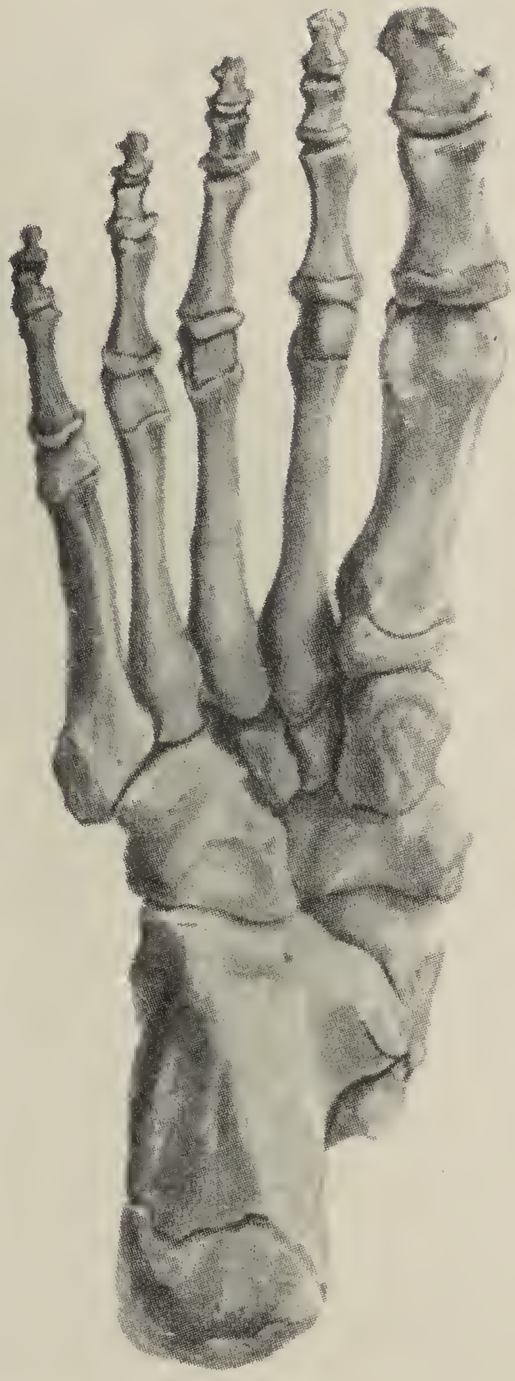
Tibia (see also Fig. 246). The nucleus for its diaphysis appears on the 44th day. Its proximal epiphysis receives its nucleus as a rule shortly before birth; it grows on the anterior side of the body distalwards and forms the tuberositas tibiae (sometimes the latter receives a special nucleus between the 11th and 13th year, which quickly fuses with the epiphysis); the epiphysis unites with the corpus in the 19th—24th year. At the distal epiphysis a nucleus appears in the 2nd year; it fuses with the diaphysis in the 16th—19th year.

Fibula (see also Fig. 246). The nuclei of its diaphysis appear on the 55th day. The distal epiphysis receives its nucleus in the 2nd year (union in the 20th—22nd year). In the proximal epiphysis a nucleus appears in the 3rd—5th year (union in the 22nd—24th year).



252. Bones of the right foot of a new-born, dorsal view. Magnif.: 1:1.

(The bone substance is colored red, the rest of the skeleton is made transparent.)



253. Bones of the right foot of a 10 year old girl, plantar view. Magnif.: 1:2.

The ***Tarsus*** (see also Fig. 246).

The *Calcaneus.* The main centre or nucleus appears in the 6th fetal month, and an epiphyseal nucleus for its posterior end appears in the 7th—10th year, which unites with the main mass in the 13th—20th year.

Talus: One nucleus in the 6th fetal month.

Os cuboideum: One nucleus shortly before birth.

Os cuneiforme III: One nucleus in the 1st year.

Os cuneiforme I: One nucleus in the 2nd—4th year.

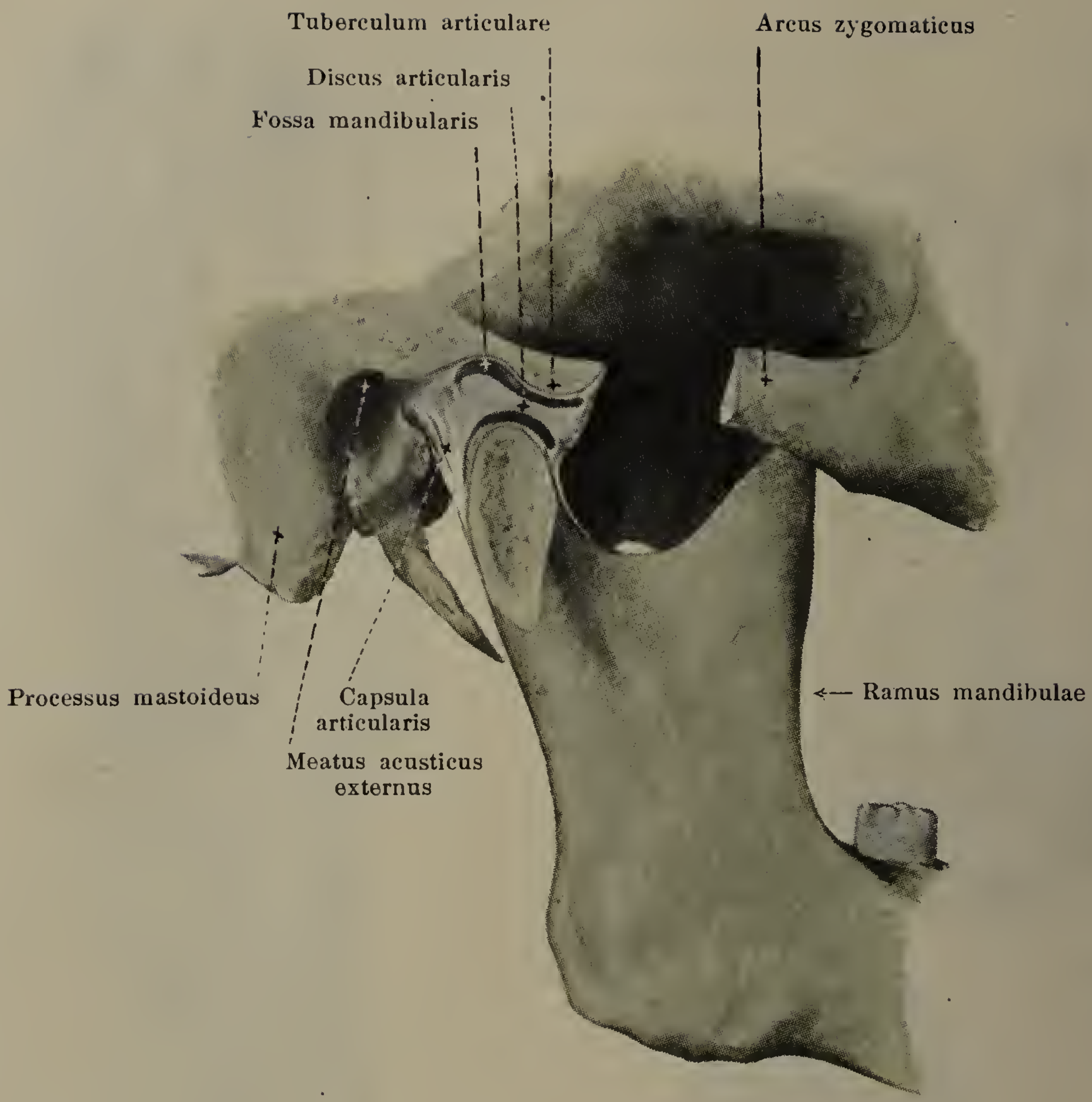
Os cuneiforme II: One nucleus in the 3rd—4th year.

Os naviculare: One nucleus in the 4th—5th year.

Ossa metatarsalia (see also Fig. 246). The nuclei of their diaphyses appear in the 8th—10th week. The epiphyses (at the proximal end in os metatarsale I and at the distal end in ossa metatarsalia II—V) receive their nuclei in the 3rd—8th year and unite with the diaphyses between the 14th and 21st year.

Phalanges (see also Fig. 246). In the 1st row the nuclei for the diaphyses appear in the 3rd fetal month, and those for the (proximal) epiphyses in the 3rd year; in the 2nd row the nuclei for the diaphyses appear in the 4th—10th fetal month and those for the (proximal) epiphyses in the 3rd year; in the 3rd row the nuclei for the diaphyses appear on the 9th week, and those for the (proximal) epiphyses in the 4th year. Union of the epiphyses with the diaphyses occurs between the 14th and 21th year.

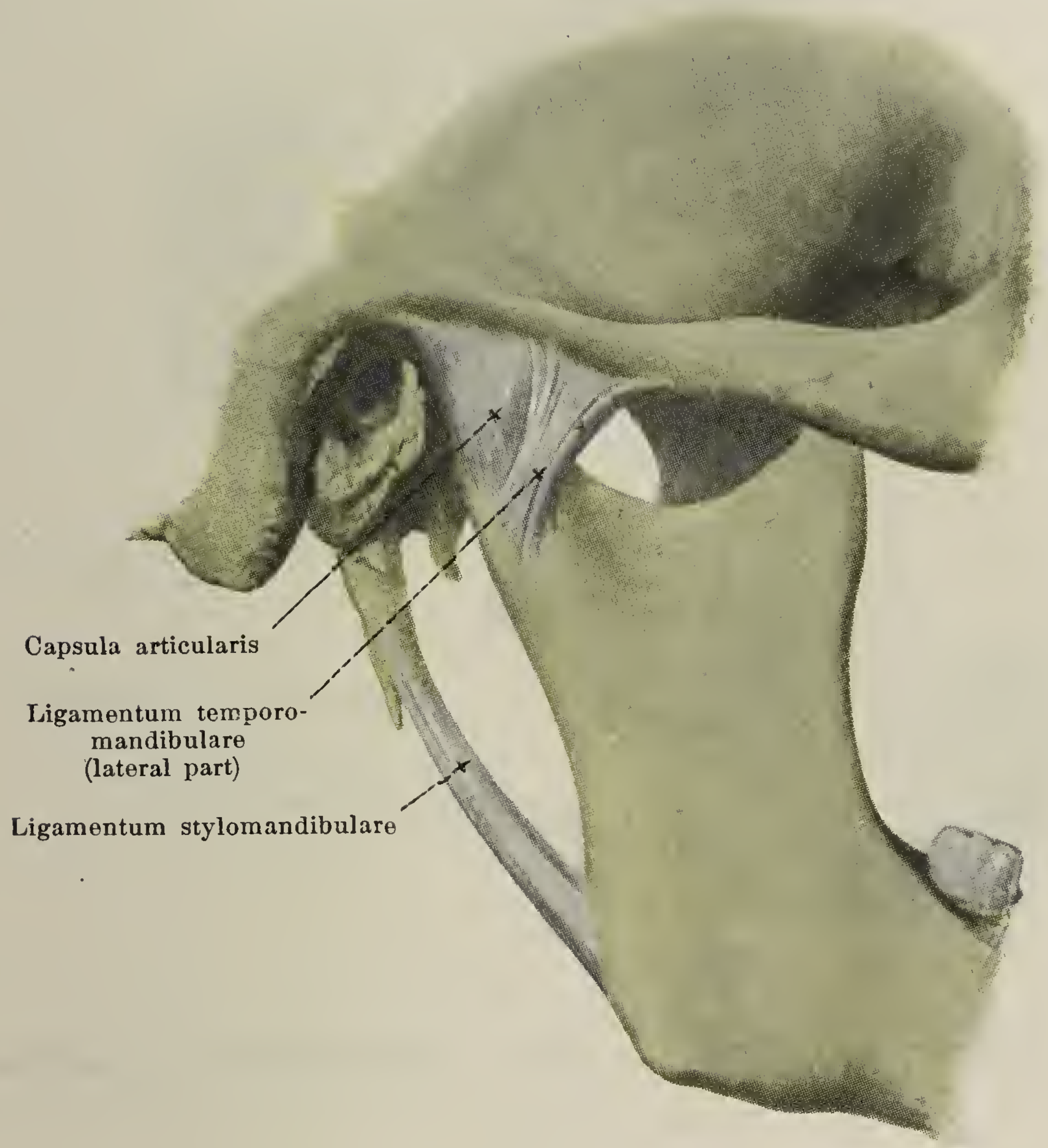
The ***ossa sesamoidea*** of the big toe ossify in the 12th—14th year.



254. **Jaw joint of right side,** ***articulatio mandibularis,*** from without.

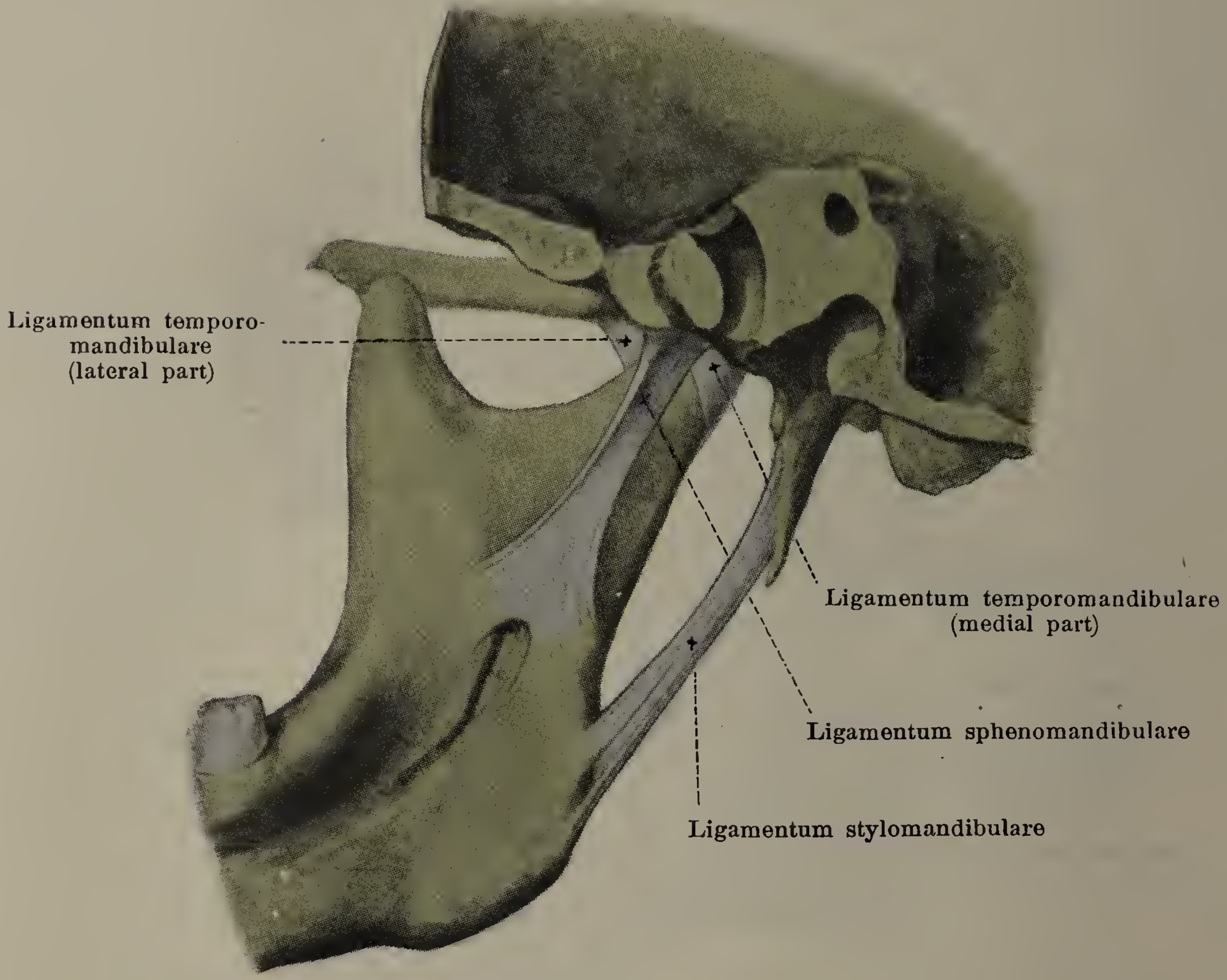
(The arcus zygomaticus and the processus condyloideus mandibulae have been partially removed; the parts have been somewhat drawn off from one another.)

By means of the **articulatio mandibularis** *(joint of the jaw)* (O. T. temporo-maxillary articulation) (see also Figs. 255—257) the lower jaw is movably connected with the rest of the skull. The capitulum of the processus condyloideus mandibulae on each side rests on the posterior slope of the tuberculum articulare in the fossa mandibularis ossis temporalis. The facies articularis extends into the fossa mandibularis not quite as far as the fissura petrotympanica where it is for the most part covered by connective tissue and only in its most anterior portion covered with cartilage; in front it goes over upon the tuberculum articulare which is covered with cartilage and does not end until its anterior slope is reached. The cartilaginous covering consists of fibrocartilage. Between the processus condyloideus on the one side and the fossa mandibularis and tuberculum articulare on the other is inserted a connective tissue disc, ***discus articularis*** (O. T. interarticular fibrocartilage), which is thinner in the middle, thicker in front and behind an about of the shape of a biconcave, transversely placed plate. The ***capsula articularis*** (O. T. capsular ligament) is loose and is stretched from the circumference of the facies articularis of the fossa mandibularis and of the tuberculum articulare to the upper margin of the discus articularis, as well as from the lower border of the latter to the collum of the processus condyloideus mandibulae covered in its anterior part with fibrocartilage; it extends further down in the back than in front. In this way two joint cavities, completely separated from one another, are formed, an upper and a lower, which are separated from one another by the articular disc; very rarely they communicate by a cleft in the articular disc.


Capsula articularis
Ligamentum temporo-mandibulare (lateral part)
Ligamentum stylomandibulare

255. Jaw joint of right side, *articulatio mandibularis,* from without.

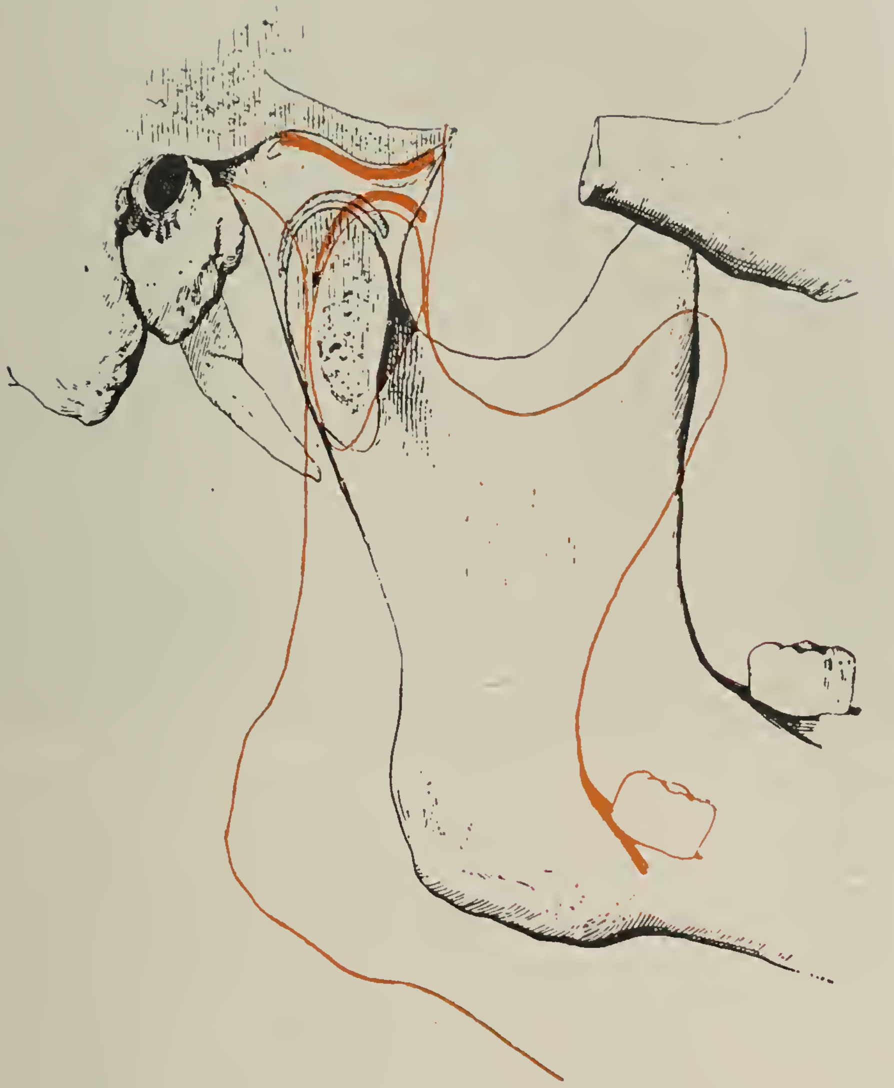
Articulatio mandibularis (continued). Passing obliquely from in front and above backward and downward, as a strengthening ligament of the capsula articularis, is the *ligamentum temporomandibulare* (O. T. external lateral ligament). It arises on the lateral surface by a broad base at the root of the processus zygomaticus ossis temporalis and is fastened to the lateral and posterior side of the collum of the processus condyloideus mandibulae; the main mass of its fibres arises from the region of the tuberculum articulare and is to be limited often from the feebler dorsal part of the capsula articularis. Medianward a weaker fibrous band proceeds from the region of the fissura petrotympanica to the collum processus condyloidei mandibulae (see Fig. 256).


Ligamentum temporo-mandibulare (lateral part)
Ligamentum temporomandibulare (medial part)
Ligamentum sphenomandibulare
Ligamentum stylomandibulare

256. Jaw joint of right side, *articulatio mandibularis,* from within.

Articulatio mandibularis (continued). On the medial side of the jaw joint the *ligamentum sphenomandibulare* proceeds from above and behind, downward and forward. It arises from the spina angularis ossis sphenoidalis and from the fissura petrotympanica ossis temporalis and ends with a broad insertion at the lingula mandibulae, at the inner surface of the ramus of the lower jaw, and close to the lingula mandibulae, where it bridges over the beginning of the sulcus mylohyoideus. It develops from a part of the embryonal Meckel's cartilage (see p. 71) and is separated from the medial fibrous band of the ligamentum temporomandibulare and from the processus condyloideus mandibulae by a space through which runs the a. maxillaris interna with the veins accompanying it (see page 467) and the n. auriculotemporalis

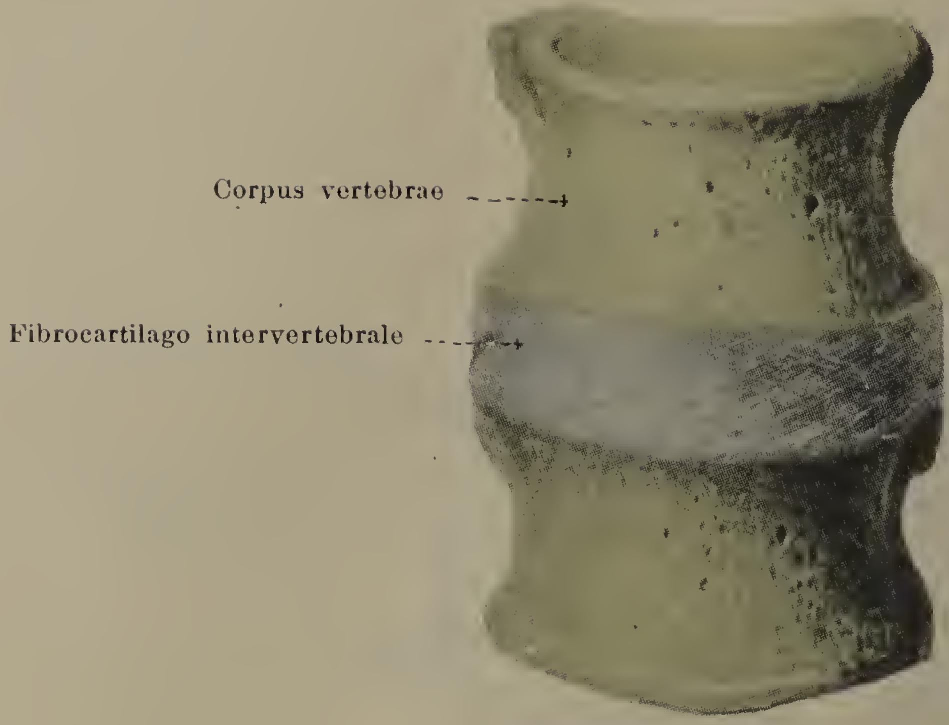
The *ligamentum stylomandibulare* (O. T. stylo-maxillary ligament) arises in common with the ligamentum stylohyoideum (see page 42) from the processus styloideus, runs obliquely forward and downward and is fastened by broad attachment to the inner side of the angulus mandibulae. It is only a band of the fascia buccopharyngea (see page 265) and has nothing to do with the joint of the jaw.



257. Jaw joint of right side, *articulatio mandibularis,* from without; somewhat schematic.

(The position of the lower jaw when the mouth is shut is indicated in black; when the mouth is wide open in red.)

Articulatio mandibularis (continued). When the mouth is closed the capitulum of the processus condyloideus is in contact with the posterior slope of the tuberculum articulare and the anterior portion of the fossa mandibularis; when the mouth is wide open it stands somewhat in front of the deepest point of the tuberculum articulare; in both cases, however, the capitulum is separated from the points of the temporal bone mentioned by the discus articularis.

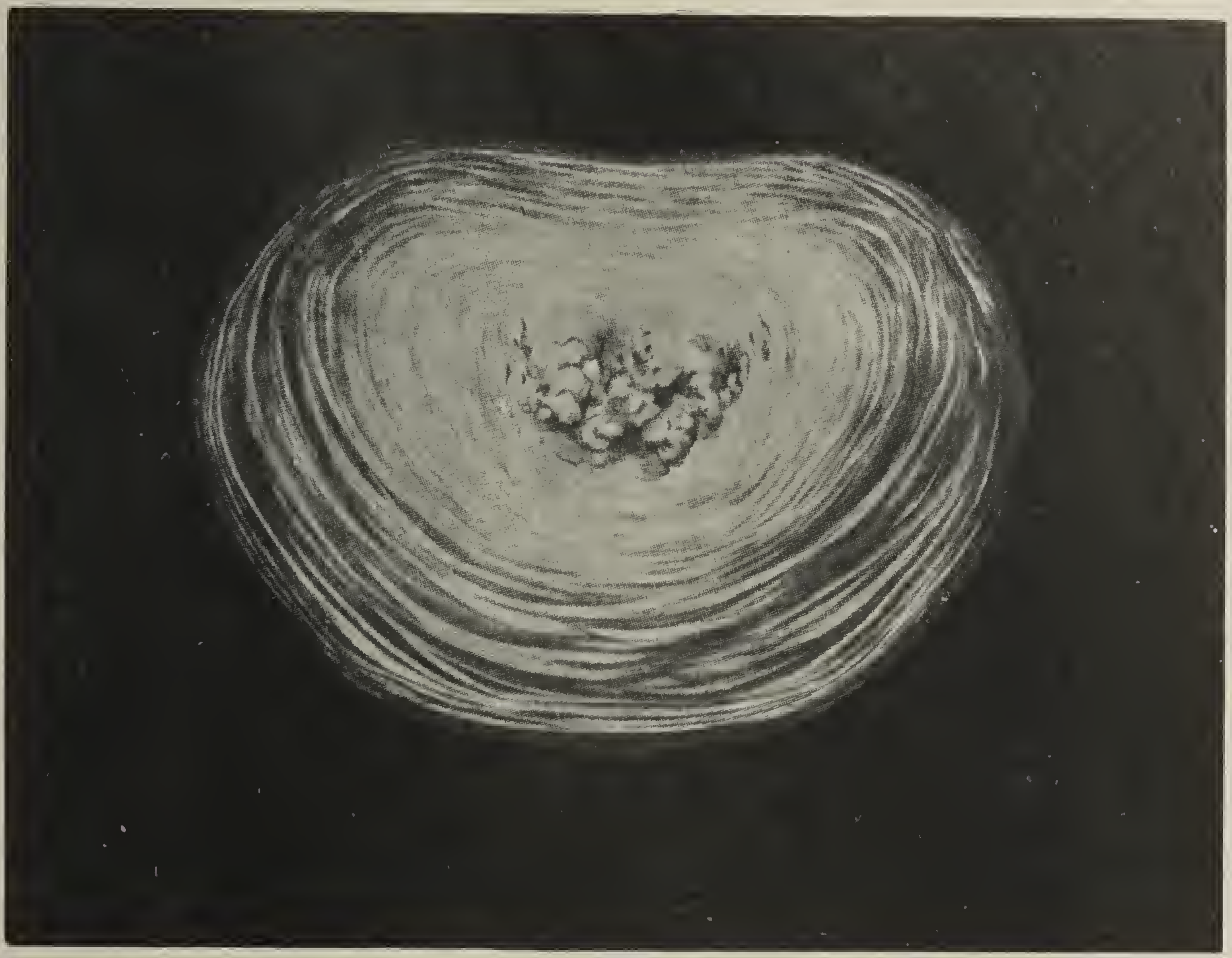


258. Intervertebral disc, *fibrocartilago intervertebralis*, with the adjacent vertebral bodies, from in front.

The individual parts of the vertebral column are held together by the **ligamenta columnae vertebralis** *(spinal ligaments)*. These consist partly of short ligament masses or ligaments which connect similar parts of adjacent vertebrae with one another, and partly of long ligaments which extend over the entire vertebral column or large parts of it. To the short ones belong the *fibrocartilagines intervertebrales* between every two vertebral bodies, the *capsulae articulares,* which unite the processus articulares inferiores of every vertebra with the processus articulares superiores of the next vertebra but one below, the *ligamenta flava* between each two vertebral bones, *ligamenta intertransversaria* between each two processus transversi and the *ligamenta interspinalia* between each two processus spinosi. Long ligaments are the *ligamentum supraspinale, ligamentum longitudinale anterius* and *ligamentum longitudinale posterius.* At the upper and lower extremity of the vertebral column these ligaments sometimes differ in shape and are sometimes supplemented by ligaments of another kind.

The **fibrocartilagines intervertebrales** *(intervertebral discs)* (see also Figs. 259 and 260) are flat fibrocartilaginous discs which lie between the adjacent surfaces of every two successive vertebrae; to these surfaces they are very firmly attached by a thin layer of hyaline cartilage. They have the shape of the adjacent vertebral bodies but are somewhat larger so that at the edges they project somewhat over this. Their absolute height is smallest at the dorsal vertebrae and greatest at the cervical. In the cervical and lumbar part of the vertebral column (see Fig. 260), especially in the lumbar part, they are somewhat higher in front than behind, in the dorsal vertebral a little lower in front. The total number of intervertebral discs present down to the sacrum is 23; the uppermost is situated between the second and third cervical vertebrae, the lowermost between the fifth lumbar vertebra and the sacrum (see also page 180); smaller discs also unite the sacrum, the coccyx and the upper three coccygeal vertebrae as well as the individual sacral vertebrae until they are grown together (see also p. 99). The totality of the intervertebral discs form approximately the fifth part of the entire vertebral column.

On the five lower cervical vertebrae there is usually, on each side, between the bent up lateral part of the upper surface of each vertebral body and the adjoining portion of the intervertebral discs, a small joint cavity with a capsula articularis (see Fig. 266).

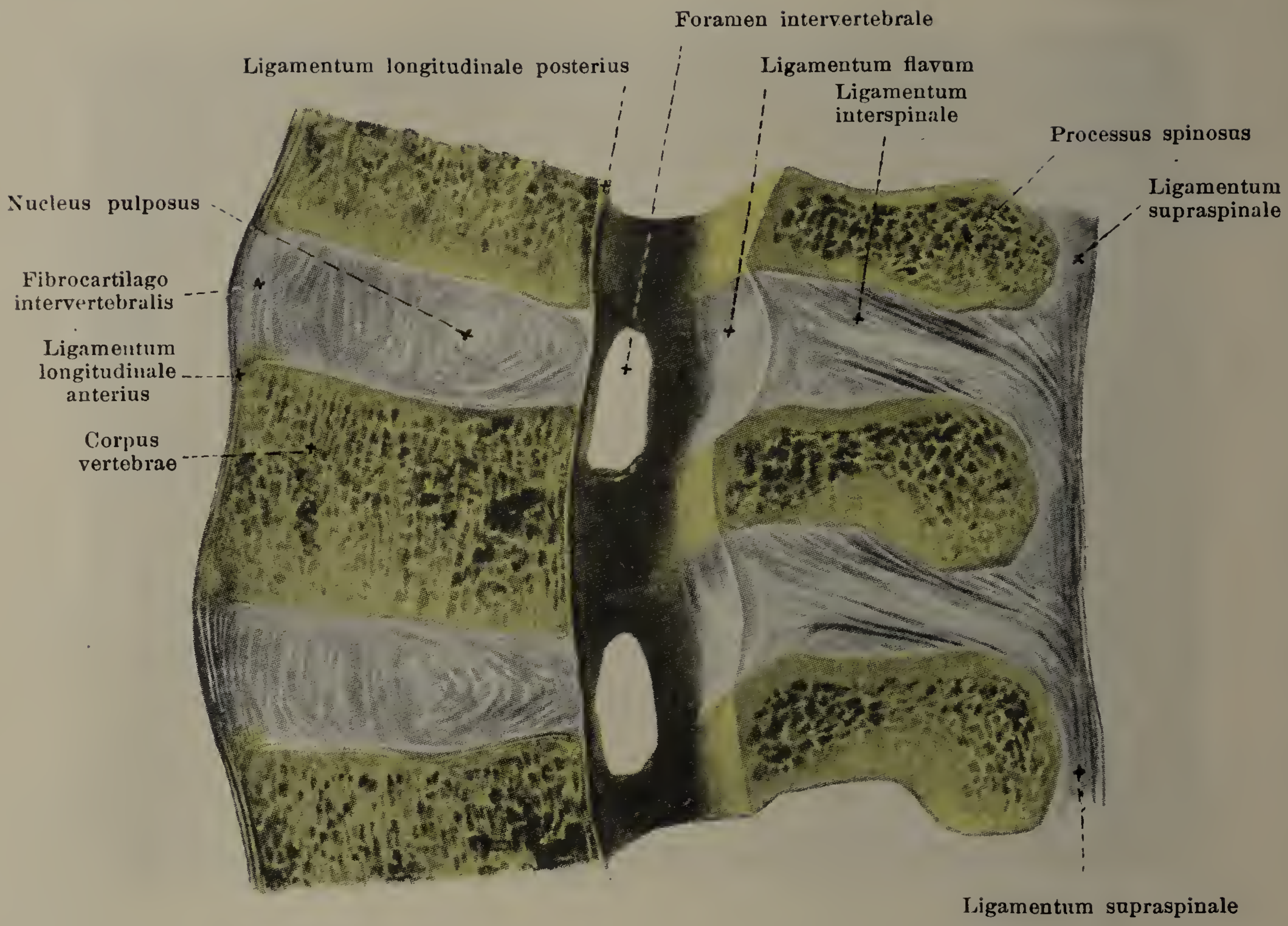


259. Intervertebral disc, *fibrocartilago intervertebralis,* cut through horizontally. Magnification: 3:2.

Each **fibrocartilago intervertebralis** consists of a firmer external portion, *annulus fibrosus,* and a softer centre, *nucleus pulposus.*

The **annulus fibrosus** (see also Figs. 258 and 260) is composed of concentric layers of connective tissue fibres which are arranged like the leaves of an onion; inside each layer the fibre bundles run obliquely and cross one another in network-like fashion. In the depth the layers are less sharply separated from one another. Between the fibre bundles in the superficial layers lie almost connective tissue cells, in the deep cartilage cells. The connective tissue layers (see Fig. 260) are anteriorly slightly convex, posteriorly on the other hand, they are kinked markedly backwards; in the middle of the discs the direction of curvature may change.

The **nucleus pulposus** (see also Fig. 260) consists essentially of a very soft mass of fibrocartilage with irregular connective tissue bands and contains the degenerated remains of the embryonic chorda dorsalis; it is separated but not sharply from its surroundings and lies excentrically, nearer the posterior circumference of the intervertebral disc (see Fig. 260). In the uninjured spinal column its constituents are under high pressure so that on cutting through the disc they project markedly.



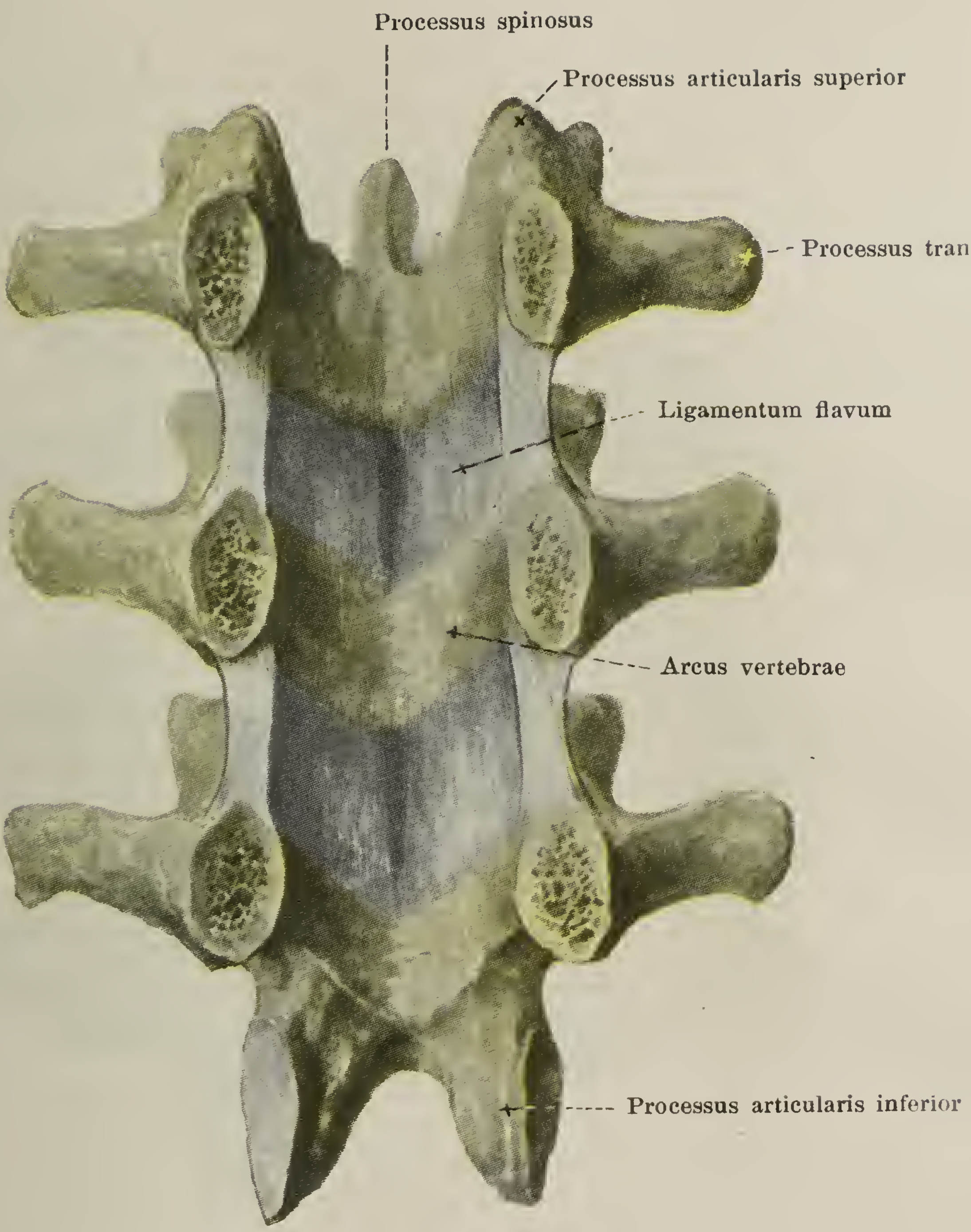
260. **Median section of a piece of the lumbar spinal column,** right half of section, viewed from the left.

The **capsulae articularis** (see Fig. 271) are stretched out between the borders of each adjacent pair of processus articulares. They are looser on the cervical than on the thoracic and lumbar vertebrae, thus allowing for greater movability.

The **ligamenta interspinalia** (see Fig. 265) are flat bands of tissue which extend between the borders of each adjacent pair of processus spinosi. They are most strongly developed on the lumbar vertebrae, feeblest on the cervical vertebrae. In general the fibres are directed from above downward and backward. In the cervical vertebrae they are connected with the ligamentum nuchae, in the other vertebrae with the ligamentum supraspinale.

The **ligamenta intertransversaria** (see Figs. 274 and 275) are rounded, thinner bands which run between the borders of every adjacent pair of processus transversi. They are strongest in the lumbar and thoracic spine, feebler (sometimes doubled) on the cervical vertebrae; they may be entirely absent from the latter. The fibres are directed from above downward.

The **ligamentum supraspinale** is a powerful, narrow ligament. It extends downward behind the tips of the spinous processes, becomes narrower between the same and fuses there with the ligamenta interspinalia. It arises partly at the tips of the processus spinosi covered with a layer of fibrocartilage and connects between them with the ligamenta interspinalia. The ligamentum supraspinale begins at the processus spinosus of the seventh cervical vertebra, is a continuation of the ligamentum nuchae, and ends below at the crista sacralis media.

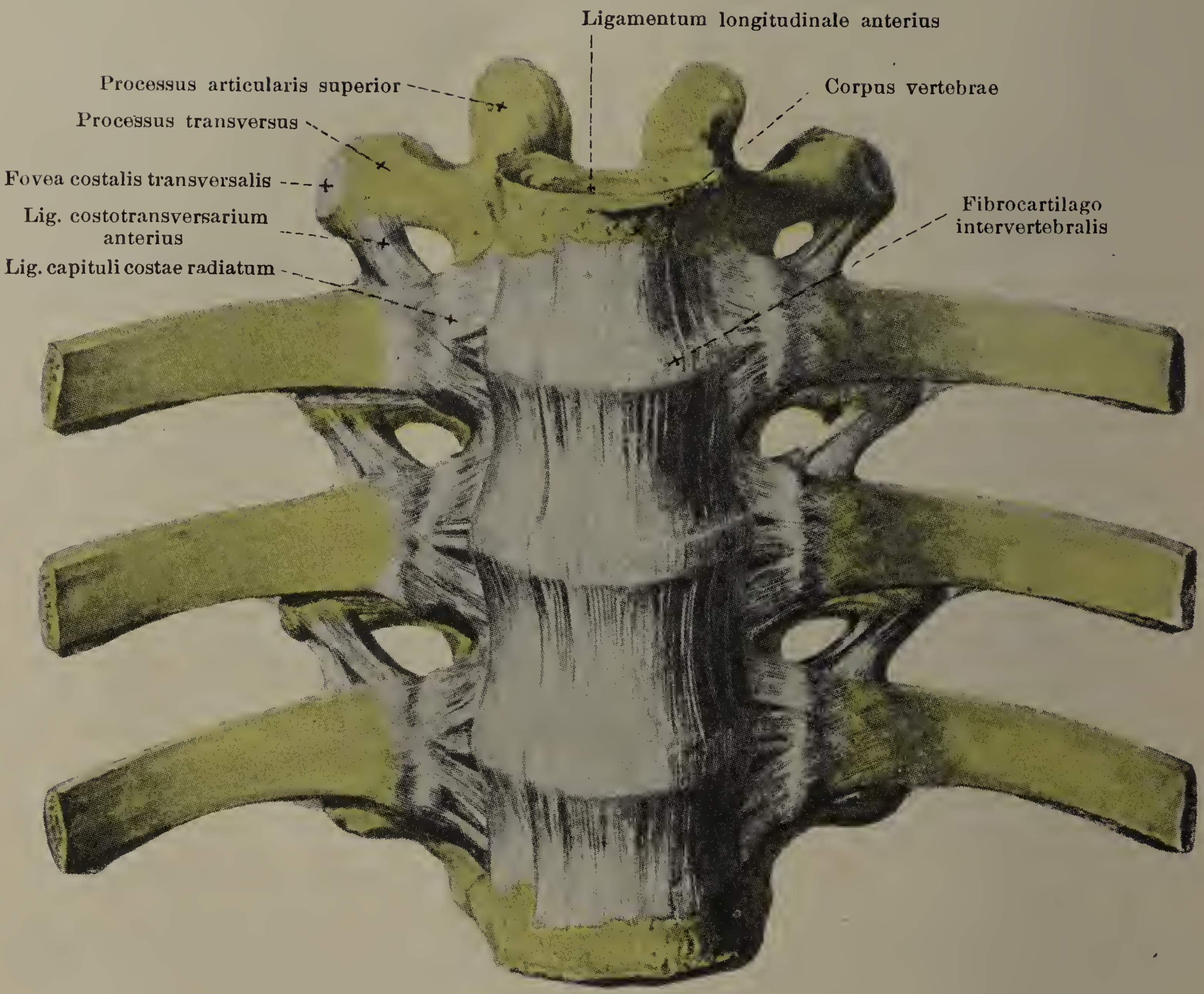


261. Lumbar vertebral arches with ligamenta flava,

from in front.

(The vertebral arches have been sawed off at their roots and the vertebral bodies removed.)

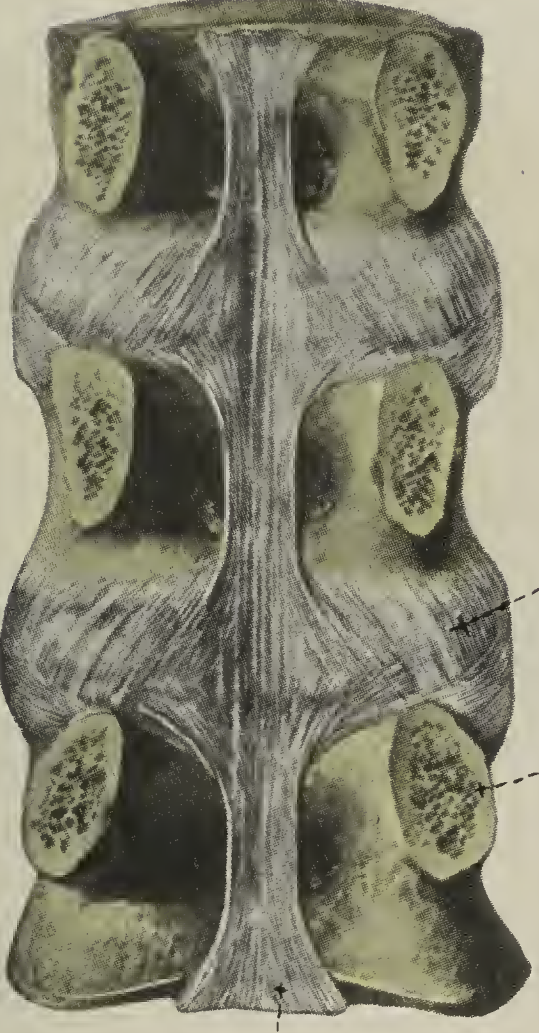
The **ligamenta flava** (see also Fig. 260) are broad flat bands stretched out between the arches of every two adjacent vertebrae and always proceed from the front surface of the higher arch to the upper edge of the lower. They are especially strong and long on the lumbar and become feebler towards the cervical vertebrae. Their fibres run in a vertical direction; in the median plane they are divided into two halves by a narrow groove. They consist almost exclusively of elastic fibres and are accordingly of a yellow color; hence the name. The band is not present in this form between the occipital bone and the atlas, nor between atlas and axis; at the former place is the membrana atlantooccipitalis posterior (see page 182), at the latter a thin membrane of connective tissue, which is strengthened only by isolated yellow stripes of elastic fibres (see Fig. 267). The lowermost one runs between the fifth lumbar vertebra and the sacrum.


Ligamentum longitudinale anterius
Processus articularis superior
Corpus vertebrae
Processus transversus
Fovea costalis transversalis
Lig. costotransversarium anterius
Fibrocartilago intervertebralis
Lig. capituli costae radiatum

262. Dorsal vertebrae and ribs with ligaments,

from in front.

The **ligamentum longitudinale anterius** descends on the anterior and lateral surfaces of the bodies of the vertebrae. It begins as a narrow tough band at the tuberculum pharyngeum ossis occipitalis (see Figs. 266 and 272), is fastened to the tuberculum anterius atlantis, then goes to the anterior surface of the epistropheus and thence to all of the bodies of the vertebrae as far as the upper part of the facies pelvina ossis sacri, where it becomes lost in the periosteum. From the epistropheus on, it becomes ever broader as it passes downward, is intimately connected with the vertebral bodies and with the fibrocartilagines intervertebrales and is divisible more or less distinctly into three stripes, a broader one in the middle and a narrower one on each side. The lateral stripes partially overlap the ligamenta capituli costae radiata. On the lumbar spine there arises tendinously from the ligamentum longitudinale anterius the main portion of the crura of the pars lumbalis diaphragmatis.

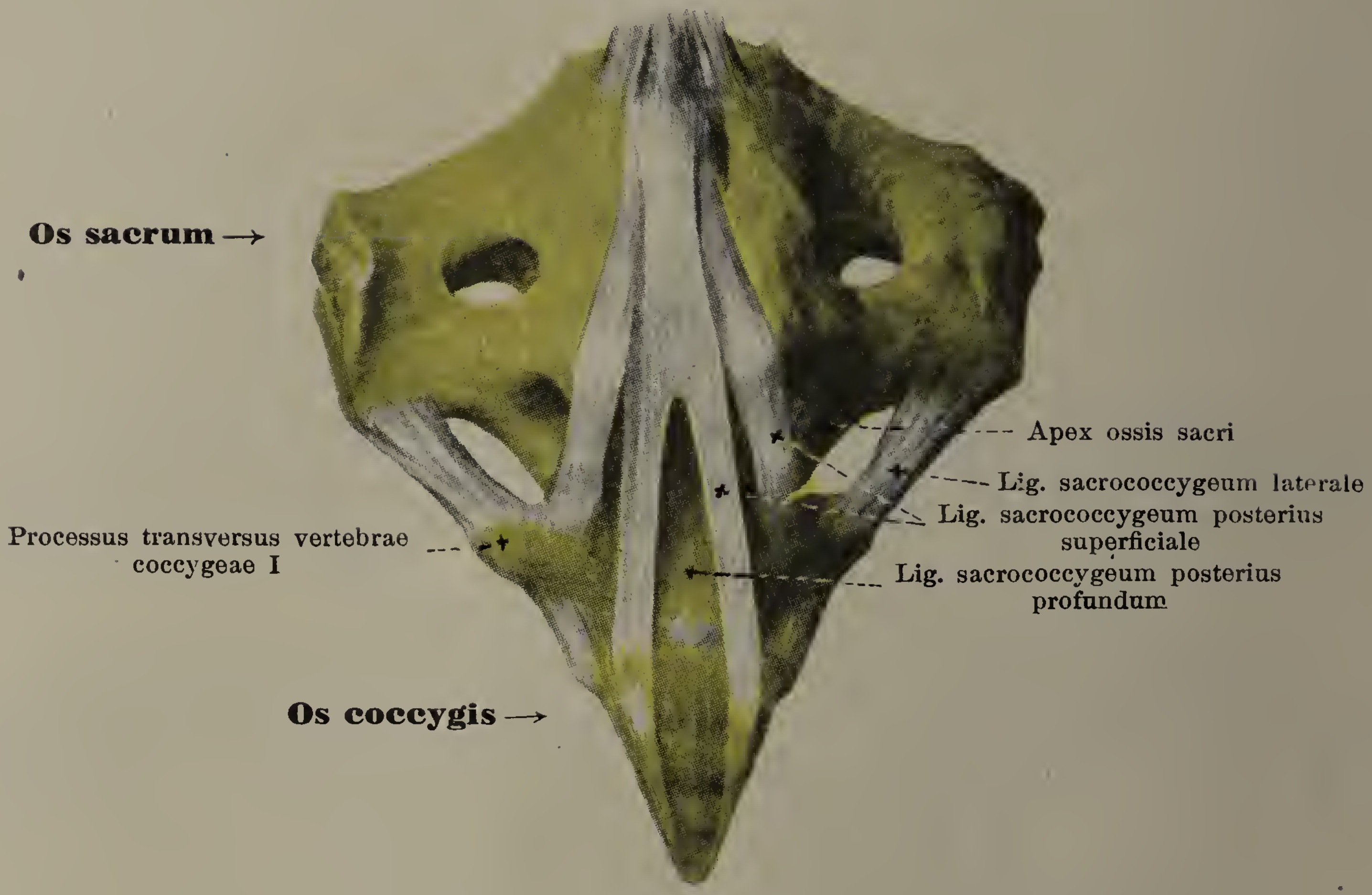

Fibrocartilago intervertebralis
Radix arcus vertebrae
Ligamentum longitudinale posterius

263. Lumbar vertebral bodies with ligaments,

from behind.

(The vertebral arches have been sawed off at their roots.)

The **ligamentum longitudinale posterius** (O. T. posterior common ligament) (see also Figs. 271 and 272) runs on the posterior surface of the vertebral bodies down inside the canalis vertebralis. It begins as an extraordinarily thin, broad layer upon the clivus and at the edge of the foramen occipitale magnum and is united as far as the third cervical vertebra with the membrana tectoria, behind which it descends, and with the dura mater. From the third cervical vertebra on it becomes narrower and stronger behind each vertebral body and is there separated from the bone by a well-developed venous plexus (see page 472); at each fibrocartilago intervertebralis it becomes considerably broader, and is especially firmly attached. It ends in the upper part of the canalis sacralis. In it can be made out deeper bands, lying near the vertebral bodies, which are short and connect the vertebrae which are close to one another, and superficial, long bands, which extend over longer distances; they are the latter alone which form the uppermost part of the ligament behind the membrana tectoria (see page 186). It is connected with the dura mater spinalis by single fibre-bands (see page 643).


Os sacrum →
Apex ossis sacri
Lig. sacrococcygeum laterale
Lig. sacrococcygeum posterius superficiale
Processus transversus vertebrae coccygeae I
Lig. sacrococcygeum posterius profundum
Os coccygis →

264. Ligaments between the sacrum and the coccyx, from behind.

The connection between the sacrum and the coccyx (**symphysis sacrococcygea**) is mediated by a thin fibrous disc; similar fibrous discs are usually present also between the first, second and third coccygeal vertebrae. These connections can wholly or in part be bony in character. The third, fourth and fifth sacral vertebrae are usually united by bony substance.

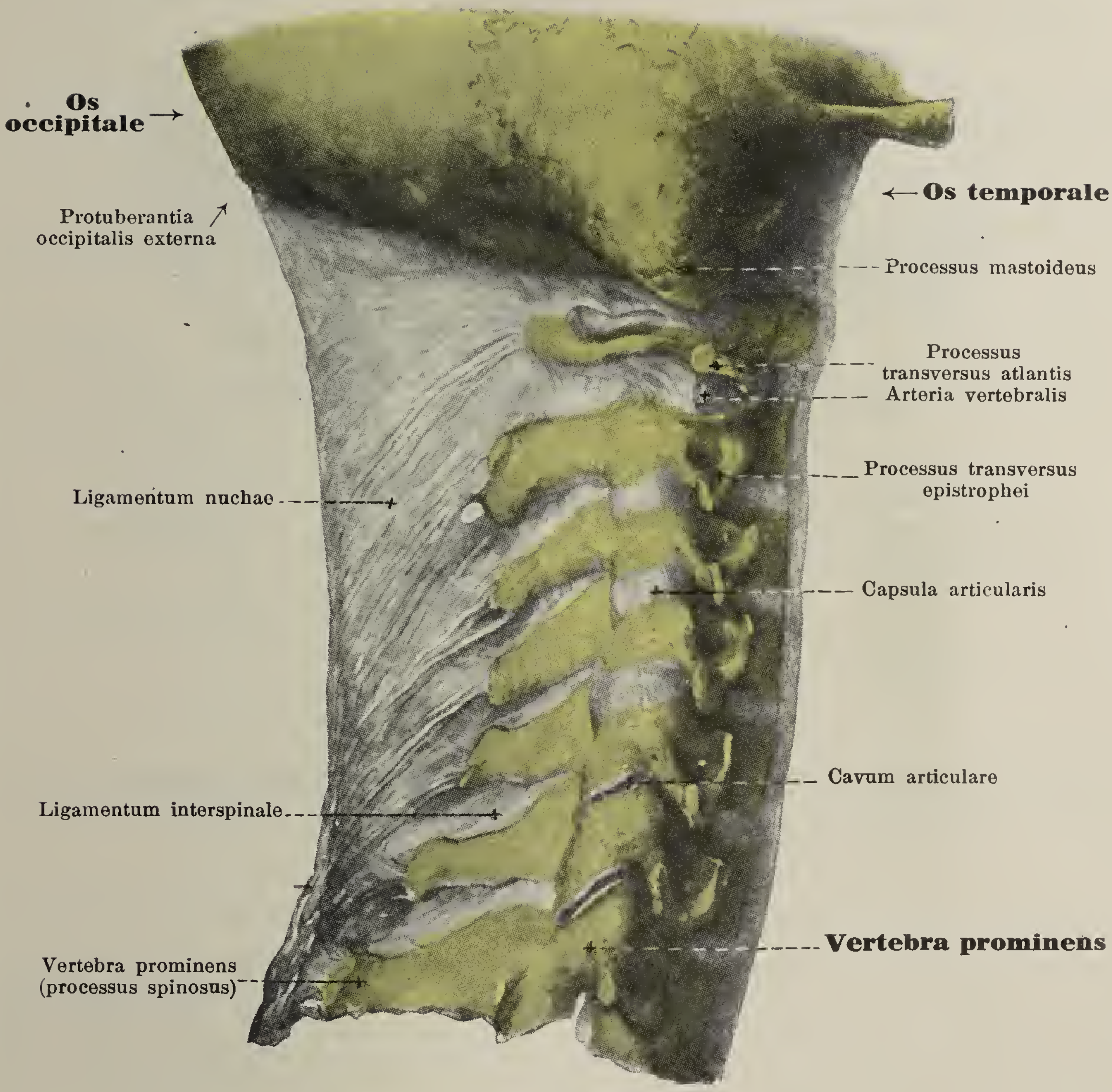
A number of ligaments also are present which are to be considered as modifications of those of the other vertebrae.

The *ligamentum sacrococcygeum anterius* (= lig. longitudinale anterius) (see Figs. 294 and 723) consists of two thin fibrous bands which extend on the anterior surface from the tip of the sacrum to the coccygeal vertebrae, crossing over one another in part; below it is attached to the m. levator ani (see page 628).

The *ligamentum sacrococcygeum laterale* (= lig. intertransversarium) runs on each side from the lower end of the crista sacralis lateralis to the processus transversus of the first coccygeal vertebra, bounds externally the notch situated lateral from the apex of the sacrum and so helps to form a fifth foramen sacrale.

The *ligamentum sacrococcygeum posterior profundum* (= lig. longitudinale posterius) lies as a thin plate immediately upon the posterior surface of the combined bodies of the sacral and coccygeal vertebrae and is connected in part with the following ligament.

The *ligamentum sacrococcygeum posterius superficiale* consists of several fibre-bands which extend on the one hand from the lower end of the crista sacralis media downward to the posterior surface of the coccyx and at the same time close the hiatus sacralis more or less completely; on the other hand, the fibre-bands extend between the cornua sacralia and the cornua coccygea. Narrow spaces between the single bands serve on both sides for the passage of the n. coccygeus. The ligament corresponds partly to the ligamenta flava, partly to the capsulae articulares.

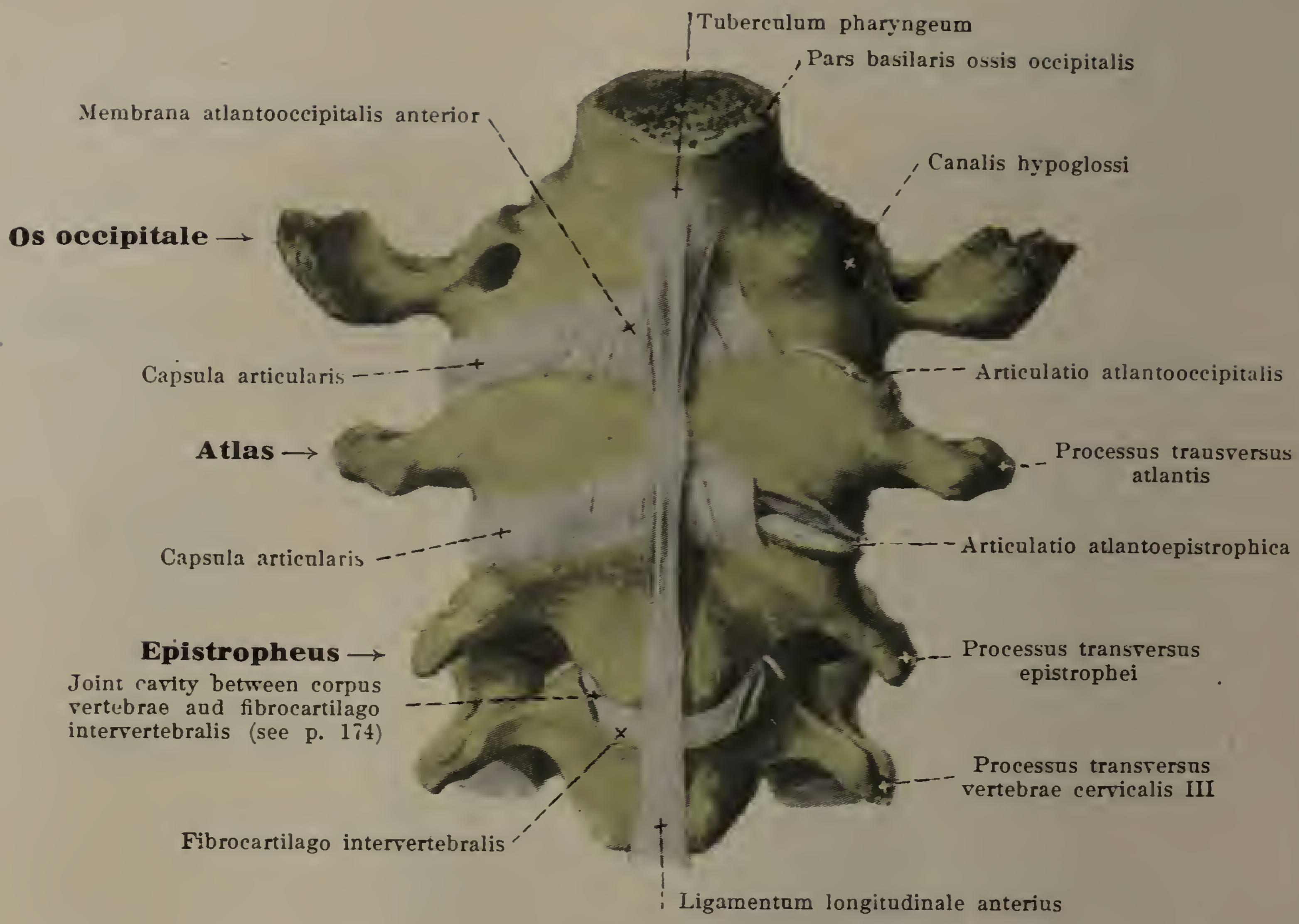


265. Skull and cervical spine with ligaments,

from the right.

(The joint slits have been partially opened.)

Between the occipital bone and the processus spinosi of the cervical vertebrae is stretched in the median plane the unpaired, triangular **ligamentum nuchae.** It is a membrane of unequal thickness and fastened above to the crista occipitalis externa, in front to the tuberculum posterius atlantis and the tips of the spinous processus from the second to the seventh cervical vertebra (from the second to the sixth vertebra to their dorsal notches). Between the spinous processes it connects with the ligamenta interspinalia, below with the ligamentum supraspinale. Its free, somewhat concave, thickened border lies close beneath the skin, goes from the protuberantia occipitalis externa to the tip of the spinous process of the seventh cervical vertebra and connects with the fascia nuchae. Within the membrane a band of stronger fibrous bundles runs backward and downward from each cervical vertebra.


Tuberculum pharyngeum
Pars basilaris ossis occipitalis
Membrana atlantooccipitalis anterior
Canalis hypoglossi
Os occipitale
Capsula articularis
Articulatio atlantooccipitalis
Atlas
Processus transversus atlantis
Capsula articularis
Articulatio atlantoepistrophica
Epistropheus
Processus transversus epistrophei
Joint cavity between corpus vertebrae and fibrocartilago intervertebralis (see p. 174)
Processus transversus vertebrae cervicalis III
Fibrocartilago intervertebralis
Ligamentum longitudinale anterius

266. Occipital bone and first three cervical vertebrae with ligaments, from in front.

(The joints have been partially opened.)

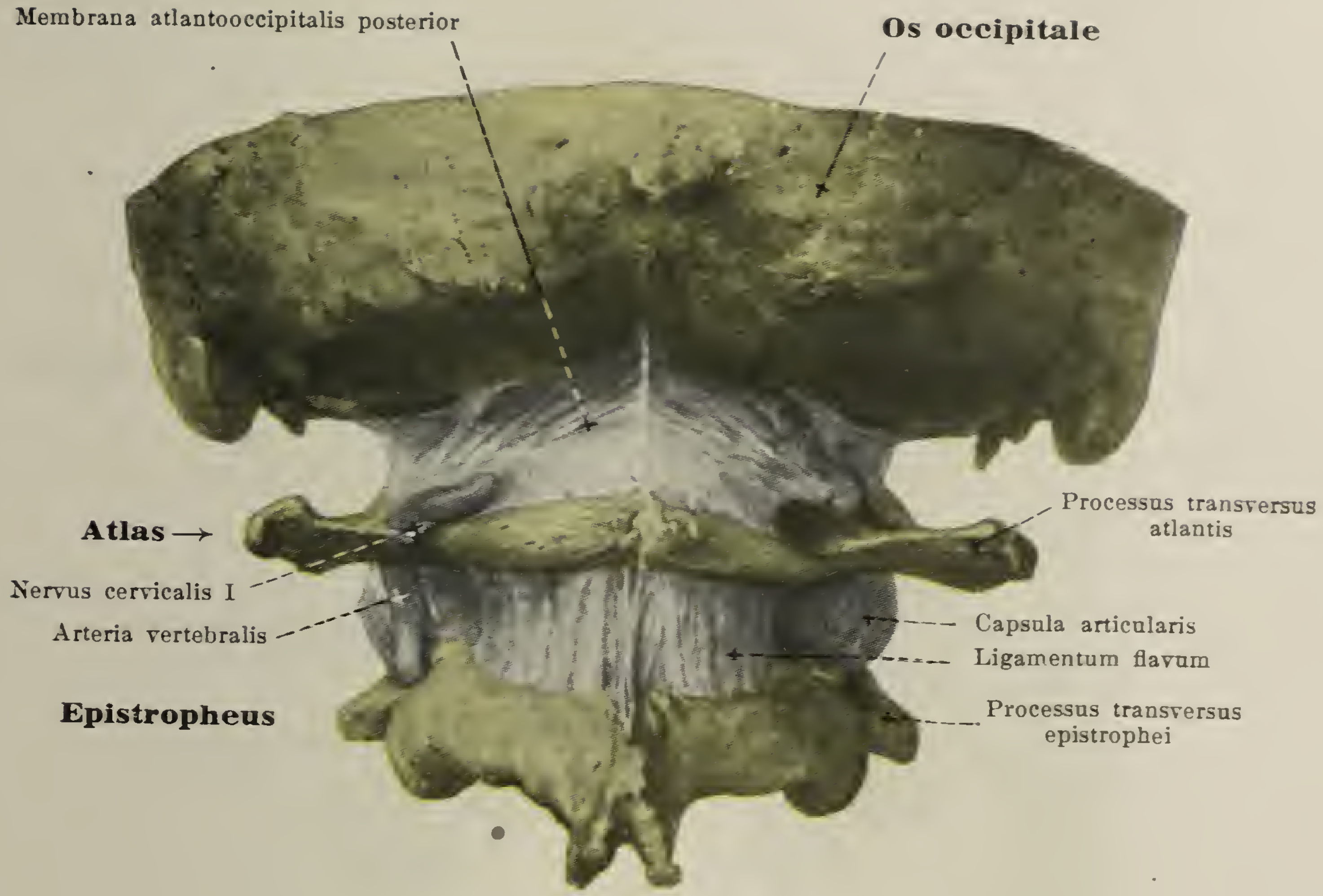
The skull is movable against the spinal column through the **head joints** which consist of the *occipital joint* and *joint for rotation of head.*

The **articulatio atlantooccipitalis** *(occipital joint,* O. T. articulation of the atlas with the occipital bone) (see also Figs. 267 and 269) is formed so that the condyli occipitales move in the foveae articulares superior atlantis. Between the borders of these cartilaginous joint-surfaces are stretched the loose *capsulae articulares* (O. T. capsular ligaments). The interspaces between the arches of the atlas and the occipital bone are filled up by the *membranae atlantooccipitales.*

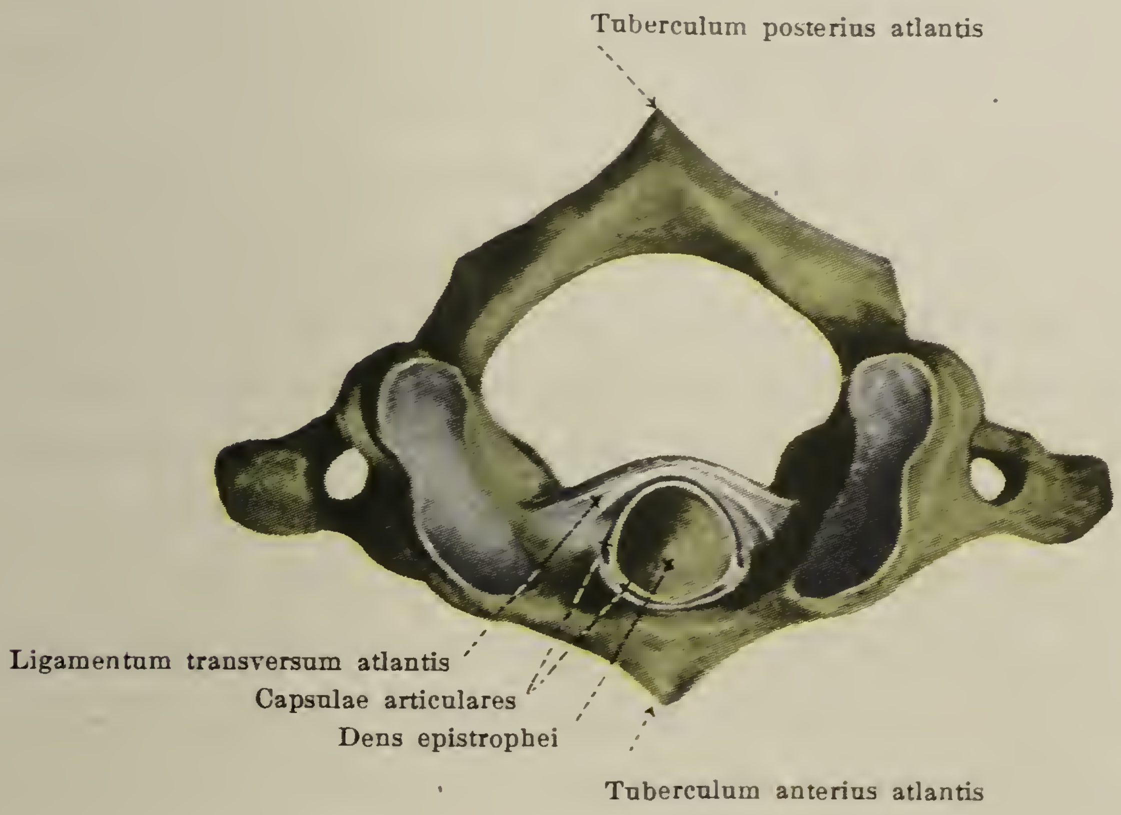
The *membrana atlantooccipitalis anterior* (O. T. anterior occipitoatlantal ligaments) extends as a short, flat, tough band between the pars basilaris ossis occipitalis and the arcus anterior atlantis; its fibres run essentially vertically. In the middle it is fused with the uppermost part of the ligamentum longitudinale anterius, at the borders with the capsulae articulares.

The *membrana atlantooccipitalis posterior* (O. T. posterior occipitoatlantal ligament) (see Figs. 267 and 272) goes from the posterior circumference of the foramen occipitale magnum to the arcus posterior atlantis. Its lower, medial part is extraordinarily thin and firmly fused with the dura mater. Its upper lateral part consists of stronger fibrous bands; they extend obliquely lateralward and downward and are fastened there to a fibrous arch, sometimes ossified, which bridges over the sulcus a. vertebralis and transforms it into a canal, through which pass the a. and v. vertebralis and the n. cervicalis I.

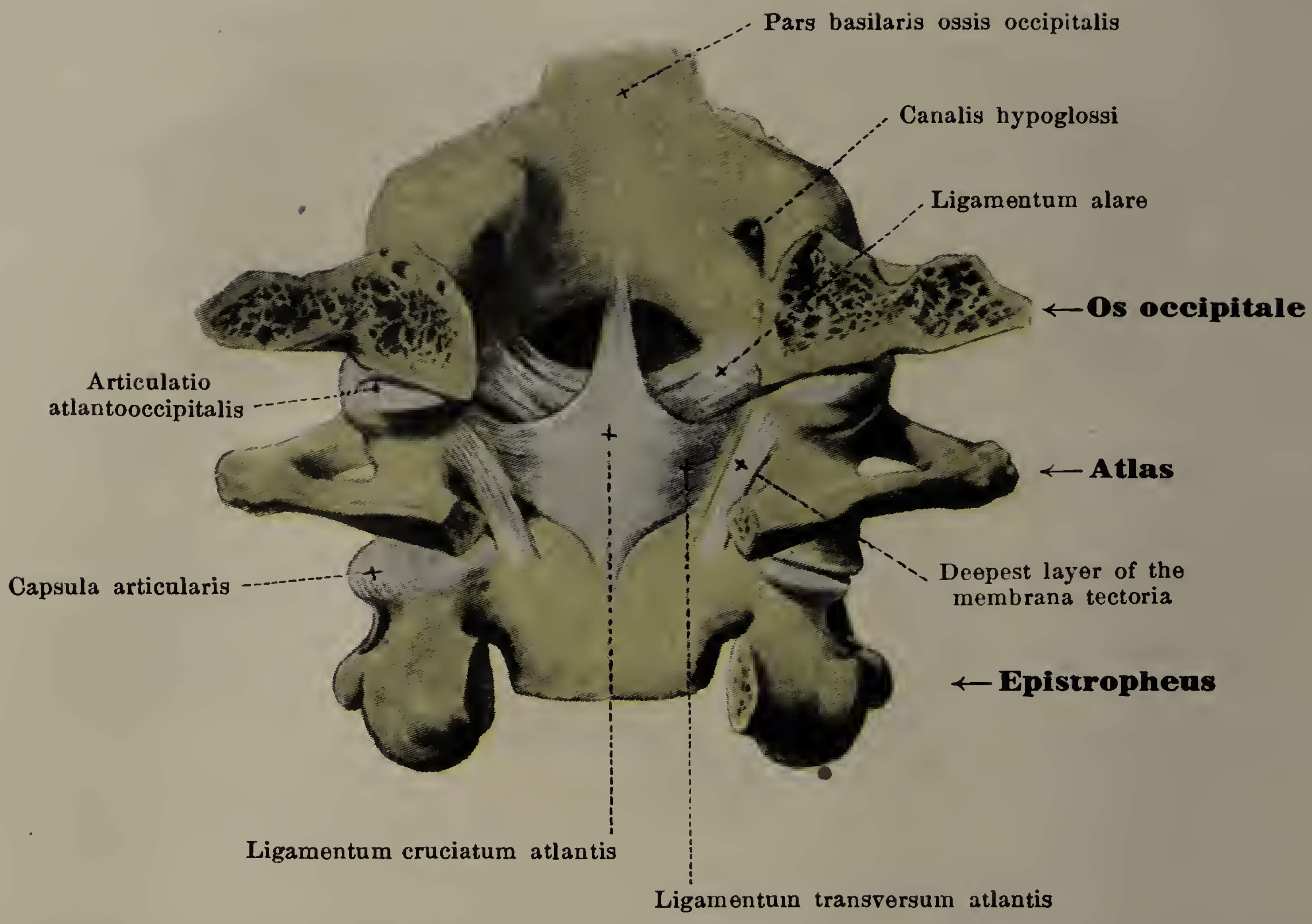
The **articulatio atlantoepistrophica** *(joint for rotation of head)* (O. T. articulation of the atlas with the axis) (see also Figs. 268—272) is formed in that the facies articulares inferiores atlantis move upon the facies articulares superiores epistrophei and that, at the same time, the dens epistrophei turns with its two facies articulares in the cylindrical space which is bounded in front by the arcus anterior atlantis, behind by the ligamentum transversum atlantis (see p. 184). Between the border of each inferior joint-surface of the atlas and the upper joint-surface of the epistropheus are stretched loose *capsulae articulares* (O. T. capsular ligaments); there is also a similar joint-capsule between the border of the fovea dentis of the atlas and the facies articularis anterior epistrophei, as well as between the circumference of the facies articularis posterior epistrophei and the anterior surface of the ligamentum transversum atlantis.



267. **Occipital bone, atlas and epistropheus with ligaments,** from behind.


Tuberculum posterius atlantis
Ligamentum transversum atlantis
Capsulae articulares
Dens epistrophei
Tuberculum anterius atlantis

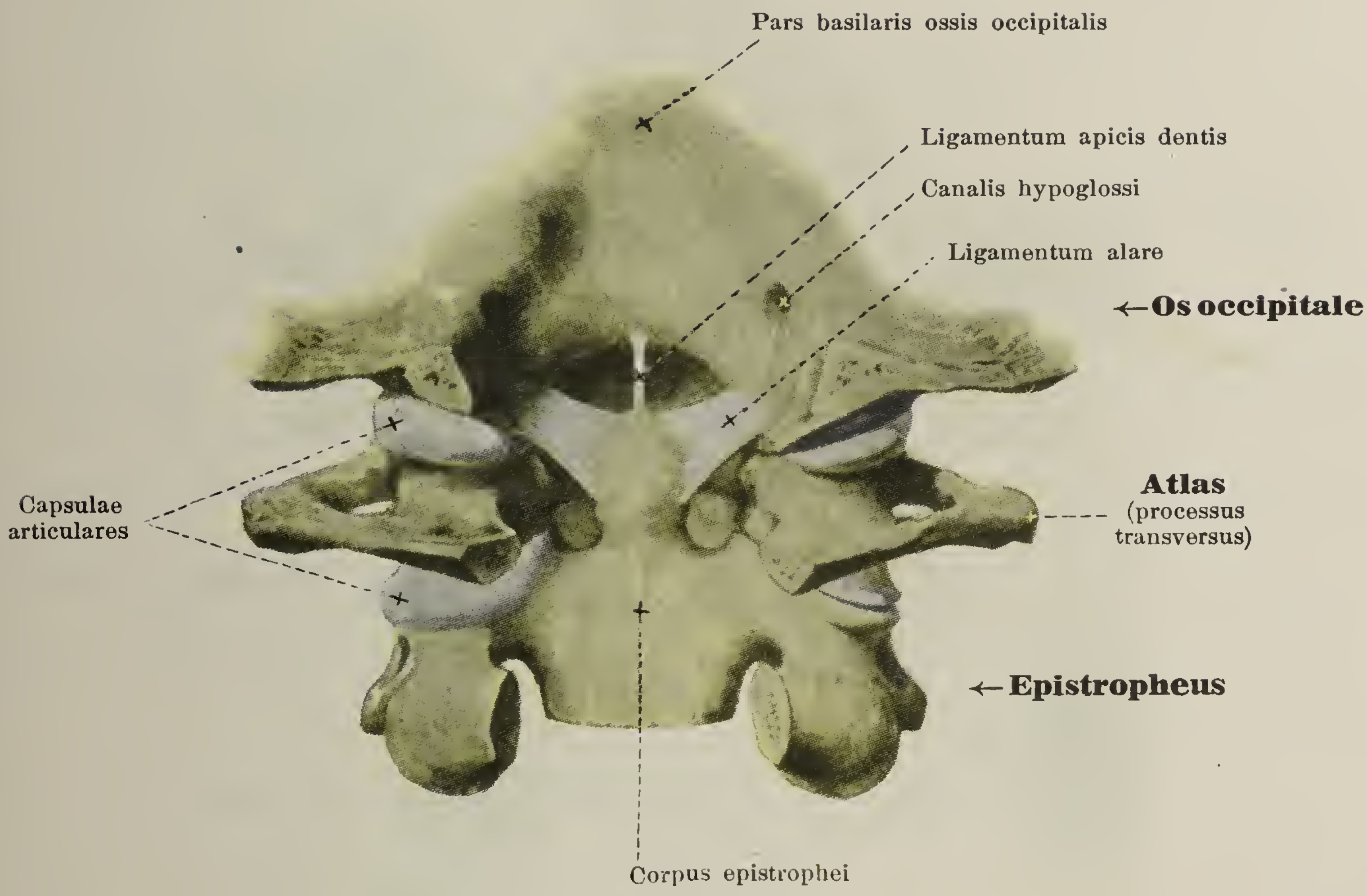
268. **Atlas and epistropheus with ligaments,** from above.


Pars basilaris ossis occipitalis
Canalis hypoglossi
Ligamentum alare
Os occipitale
Articulatio atlantooccipitalis
Atlas
Capsula articularis
Deepest layer of the membrana tectoria
Epistropheus
Ligamentum cruciatum atlantis
Ligamentum transversum atlantis

269. Occipital bone, first and second cervical vertebrae with ligaments, 3rd layer, from behind.

(The part of the occipital bone situated behind the middle of the foramen occipitale magnum and the arches of the cervical vertebrae have been removed; most of the membrana tectoria has been removed. The joint slits are partly opened.)

Articulatio atlantoepistrophica (continued). Among its essential constituents the *ligamentum transversum atlantis* (O. T. the tranverse ligament) may first be mentioned. This tough, flat ligament (see also Figs. 268 and 272) goes behind the dens epistrophei, has a broad origin from the medial surface of one massa lateralis atlantis and is equally fastened on the other side; it is curved so as to be convex behind and contains in the middle fibrocartilaginous deposits. On its anterior surface it is separated by a small joint-cavity from the odontoid process (see page 182); on its posterior surface it is united loosely with the membrana tectoria. From the middle of its upper margin a thinner bundle of fibres runs vertically upward to the anterior circumference of the foramen occipitale magnum, and from the inferior margin one runs downward to the posterior surface of the body of the second cervical vertebra. These fibre-bands together with the ligamentum transversum atlantis make up the *ligamentum cruciatum atlantis* (O. T. cruciform ligament).

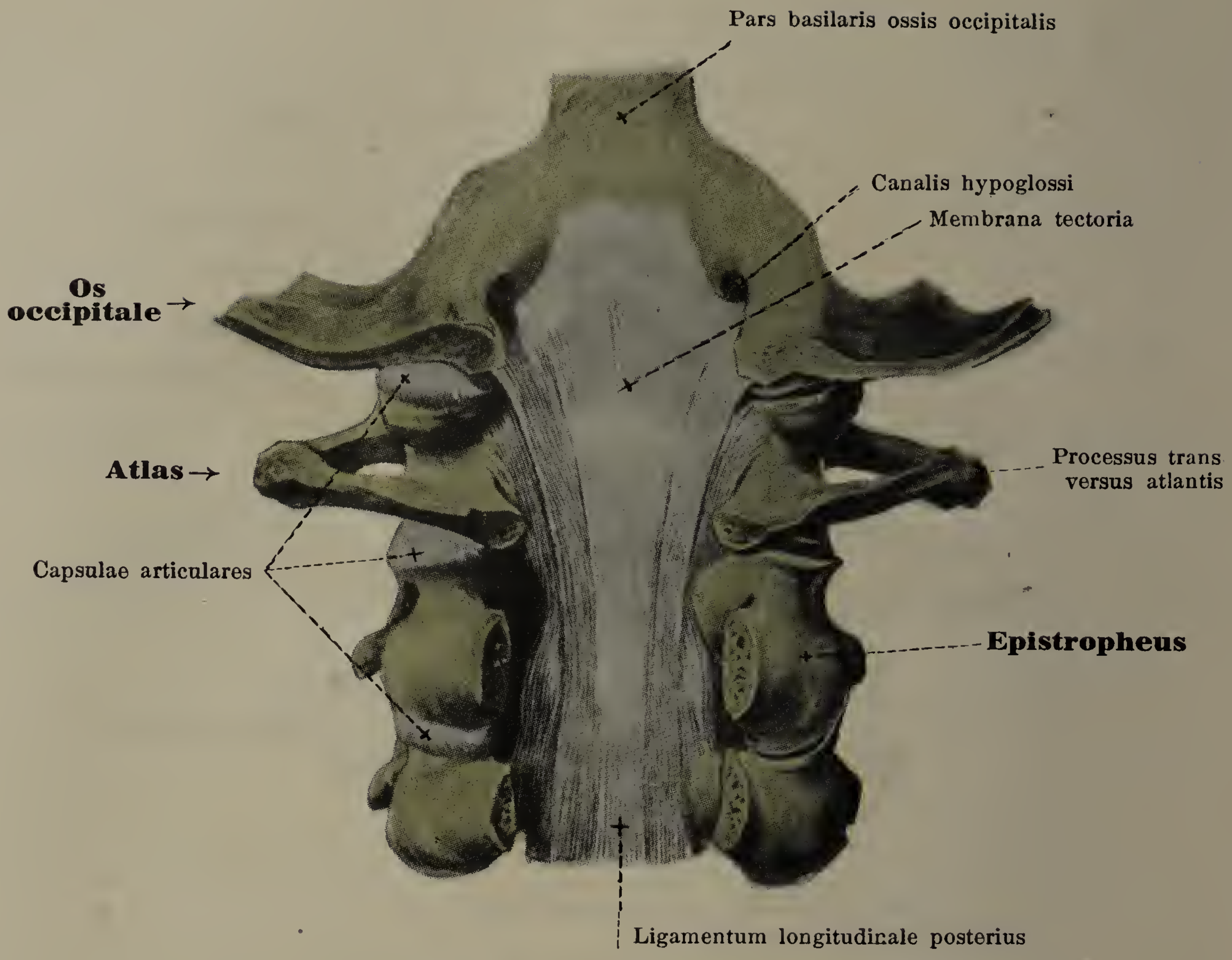


270. Occipital bone, first and second cervical vertebrae with ligaments, 4th layer, from behind.

(The part of the occipital bone situated behind the middle of the foramen occipitale magnum and the arches of the cervical vertebrae have been removed; the membrana tectoria and the ligamentum cruciatum atlantis have been completely removed. The right joint slits are opened.)

Articulatio atlantoepistrophica (continued). It is strengthened by the *ligamenta alaria* (O. T. odontoid or check ligaments) (see also Fig. 269). These are the strongest ligaments of the joint and consist on each side of a strong, flat-rounded fibre bundle which extends from the lateral surface of the dens epistrophei obliquely upward and lateralward to the medial surface of the condylus occipitalis where it is attached. They are situated, therefore, in front of the ligamentum cruciatum atlantis.

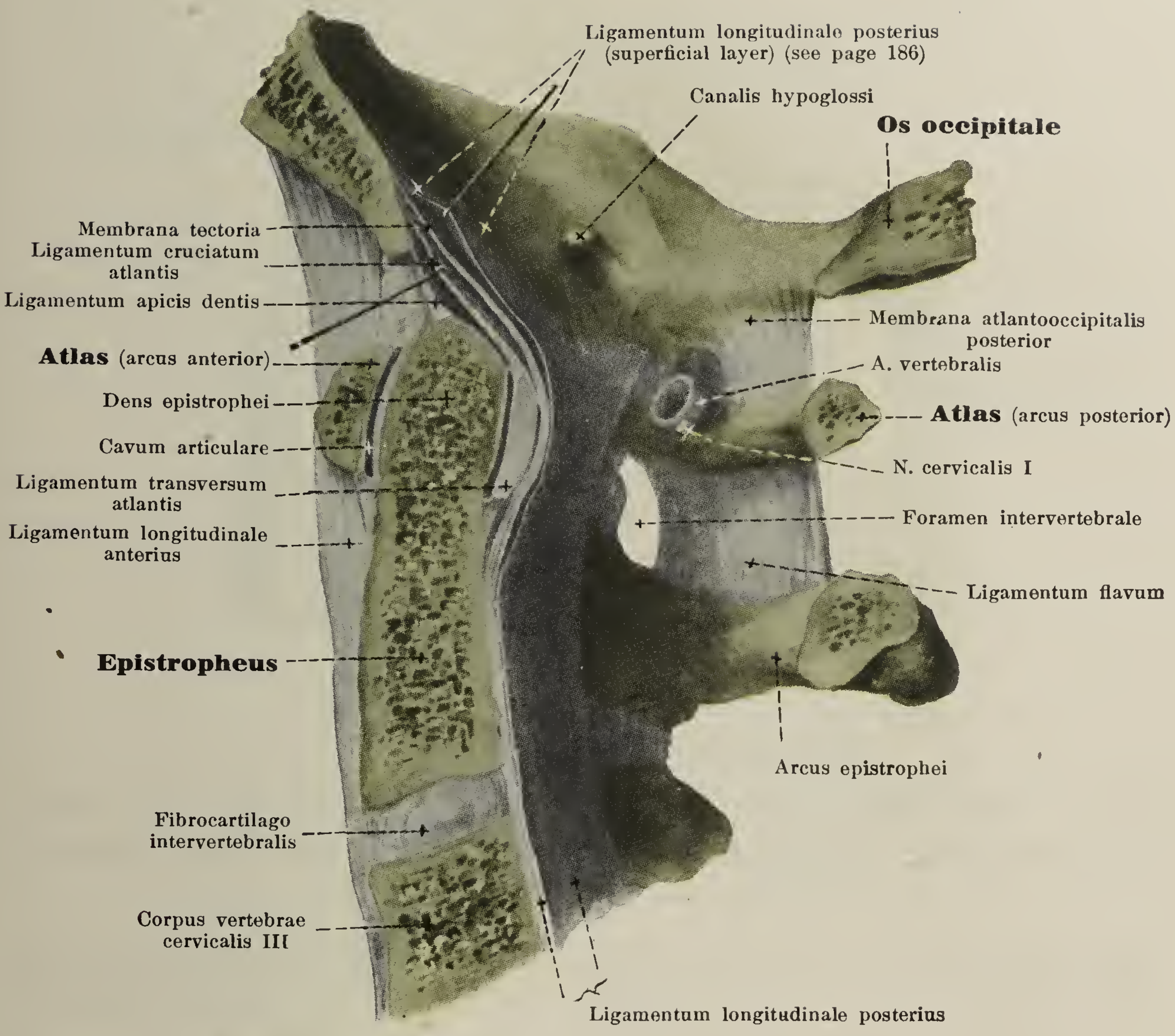
Also in front of the ligamentum cruciatum atlantis, in front of its upper vertical limb, a thin rounded band, *ligamentum apicis dentis* (O. T. ligamentum suspensorium), extends in the median plane from the tip of the odontoid process to the anterior circumference of the foramen occipitale magnum (see also Fig. 272). It is mechanically insignificant and only important because it arises from the uppermost part of the embryonic chorda dorsalis.


Pars basilaris ossis occipitalis
Canalis hypoglossi
Membrana tectoria
Os occipitale
Atlas
Processus transversus atlantis
Capsulae articulares
Epistropheus
Ligamentum longitudinale posterius

271. Occipital bone and first three cervical vertebrae with ligaments, 2nd layer, from behind.

(The part of the occipital bone situated behind the middle of the foramen occipitale magnum and the arches of the cervical vertebrae have been removed; the most superficial, thin layer of the ligamentum longitudinale posterius has also been rêmoved. The right joint slits are opened.)

The **articulatio atlantoepistrophica** is covered behind by the *membrana tectoria* (O. T. occipital-axial ligament) (see also Fig. 272). This lies as a broad, quadrangular fibrous plate behind the ligamentum cruciatum atlantis, is loosely connected with it and is separated from the dura mater of the canalis vertebralis by a very thin fibrous layer which is considered as a continuation of the superficial, long bands of the ligamentum longitudinale posterius, while the membrana tectoria itself is looked upon as the especially strongly developed uppermost part of the deep, short-fibred layer of the ligamentum longitudinale posterius (see page 179). The membrana tectoria arises jointly with the superficial layer of the ligamentum longitudinale posterius from the posterior surface of the clivus; its origin extends on the sides only to the opening of the canalis hypoglossi. It is broadest above; its fibres converge downward and become fastened in several strands to the posterior surface of the body of the epistropheus and of the 3rd cervical vertebra. Short bands of fibres between the atlas and the epistropheus join in the depth, lateralward the membrana tectoria (see Fig. 269).

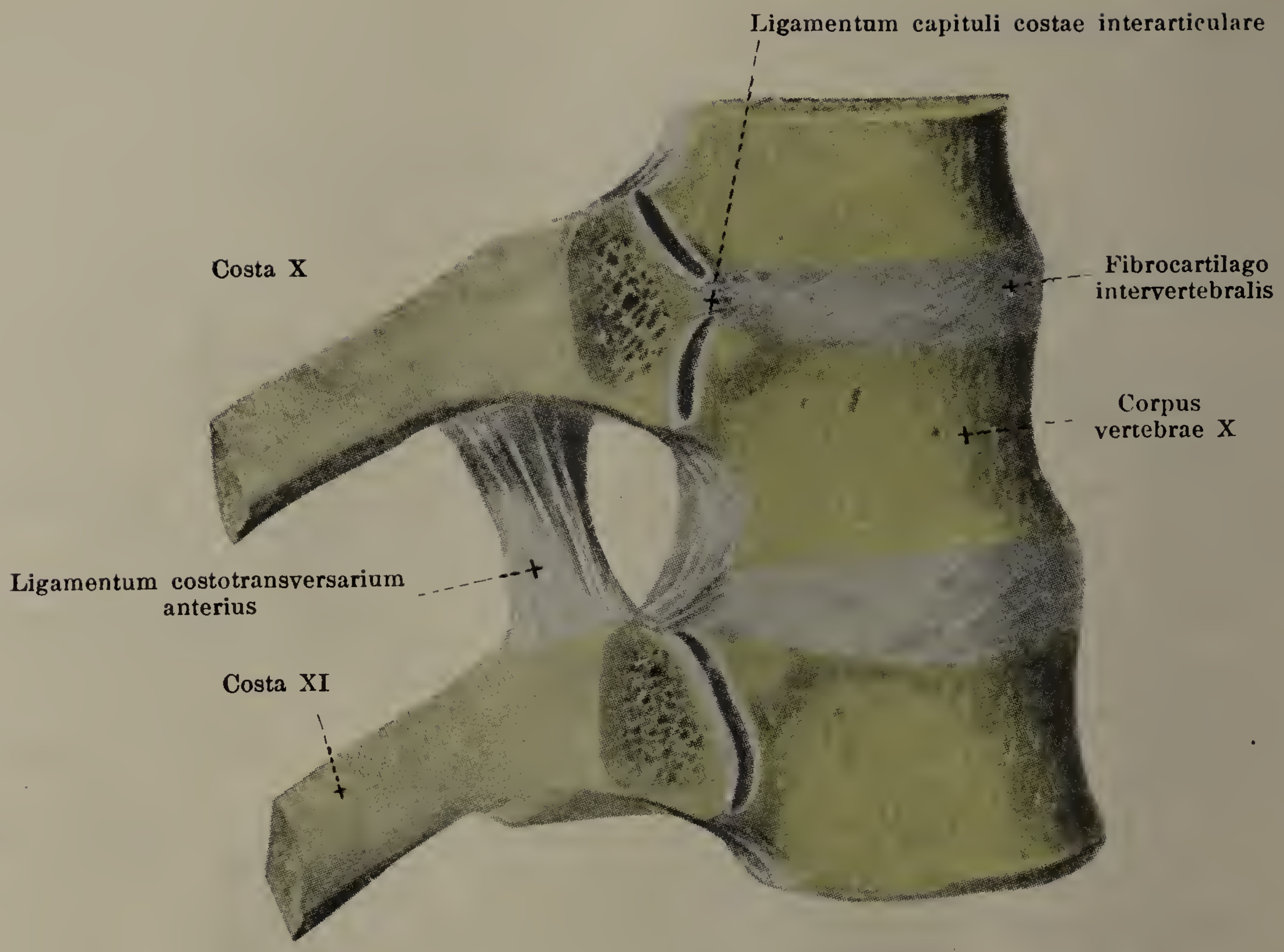

Ligamentum longitudinale posterius (superficial layer) (see page 186)
Canalis hypoglossi
Os occipitale
Membrana tectoria
Ligamentum cruciatum atlantis
Ligamentum apicis dentis
Atlas (arcus anterior)
Dens epistrophei
Cavum articulare
Ligamentum transversum atlantis
Ligamentum longitudinale anterius
Epistropheus
Fibrocartilago intervertebralis
Corpus vertebrae cervicalis III
Membrana atlantooccipitalis posterior
A. vertebralis
Atlas (arcus posterior)
N. cervicalis I
Foramen intervertebrale
Ligamentum flavum
Arcus epistrophei
Ligamentum longitudinale posterius

272. Median section through the occipital bone and first three cervical vertebrae with ligaments;
right half of section, viewed from the left, somewhat schematic.

Magnification: 4 : 3.

(The ligamentous masses have been partially drawn off from one another.)

Enumerated from before backward the ligaments of the **articulatio atlanto-occipitalis** and the **articulatio atlantoepistrophica** lie behind one another as follows: ligamentum longitudinale anterius with the membrana atlantooccipitalis anterior, ligamentum apicis dentis, ligamenta alaria, ligamentum cruciatum atlantis, membrana tectoria, ligamentum longitudinale posterius (superficial layer), membrana atlantooccipitalis posterior.


Ligamentum capituli costae interarticulare
Costa X
Fibrocartilago intervertebralis
Corpus vertebrae X
Ligamentum costotransversarium anterius
Costa XI

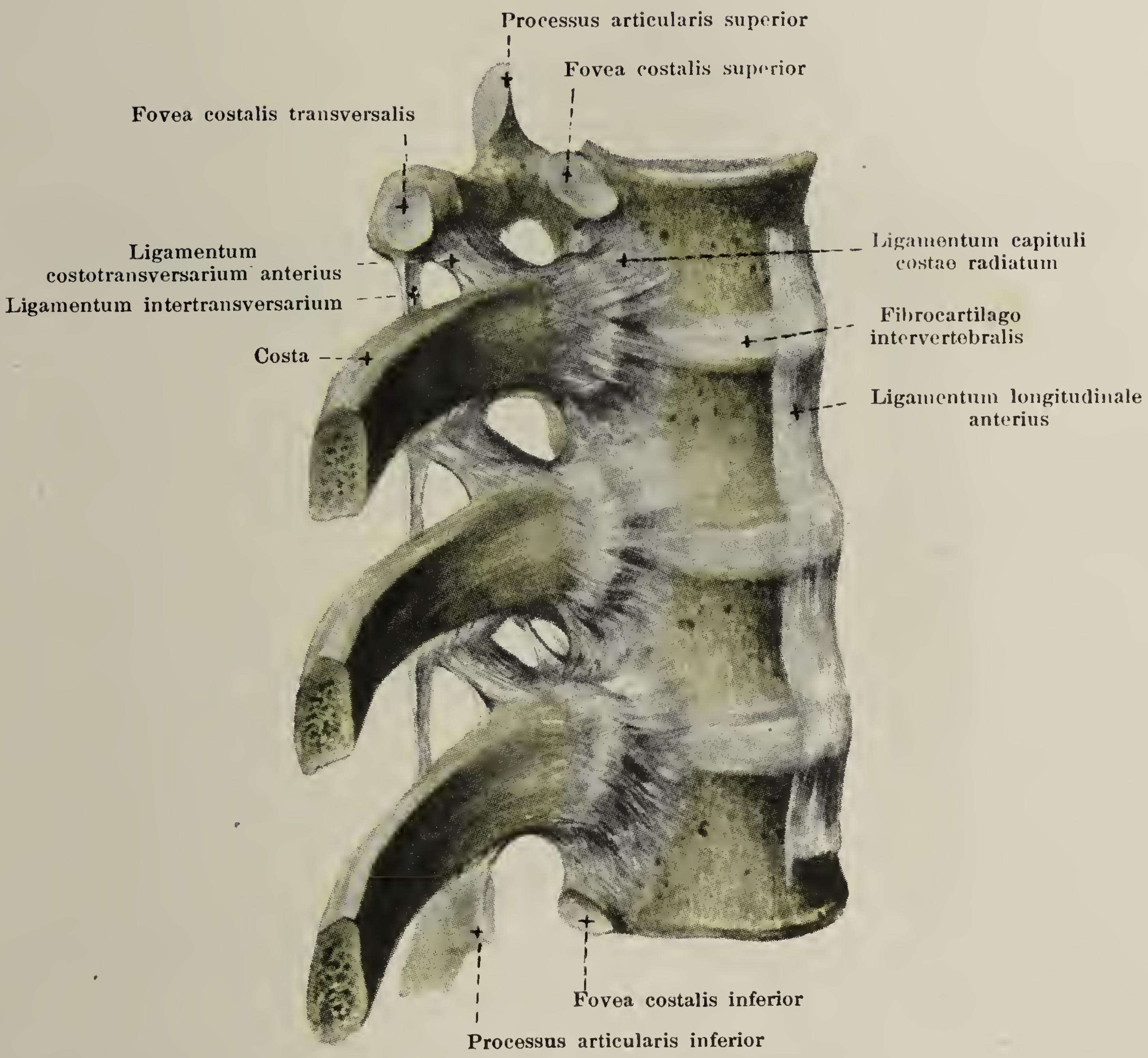
273. The right tenth and eleventh ribs and corresponding vertebral bodies with their ligaments,

viewed from the right.

(The most anterior layer has been sawed off from the heads of the ribs; the parts have been somewhat drawn off from one another. The ligamentum longitudinale anterius has been removed.)

The ribs are movably connected with the thoracic vertebrae through the **articulationes costovertebrales** *(articulations of the ribs with the vertebrae)* (see Fig. 276). Each rib is articulated at two points: the capitulum costae moves in the foveae costales of the bodies of the vertebrae *(articulatio capituli)* and at the same time the tuberculum costae rotates in the fovea costalis transversalis *(articulatio costotransversaria).* Both together form mechanically one joint.

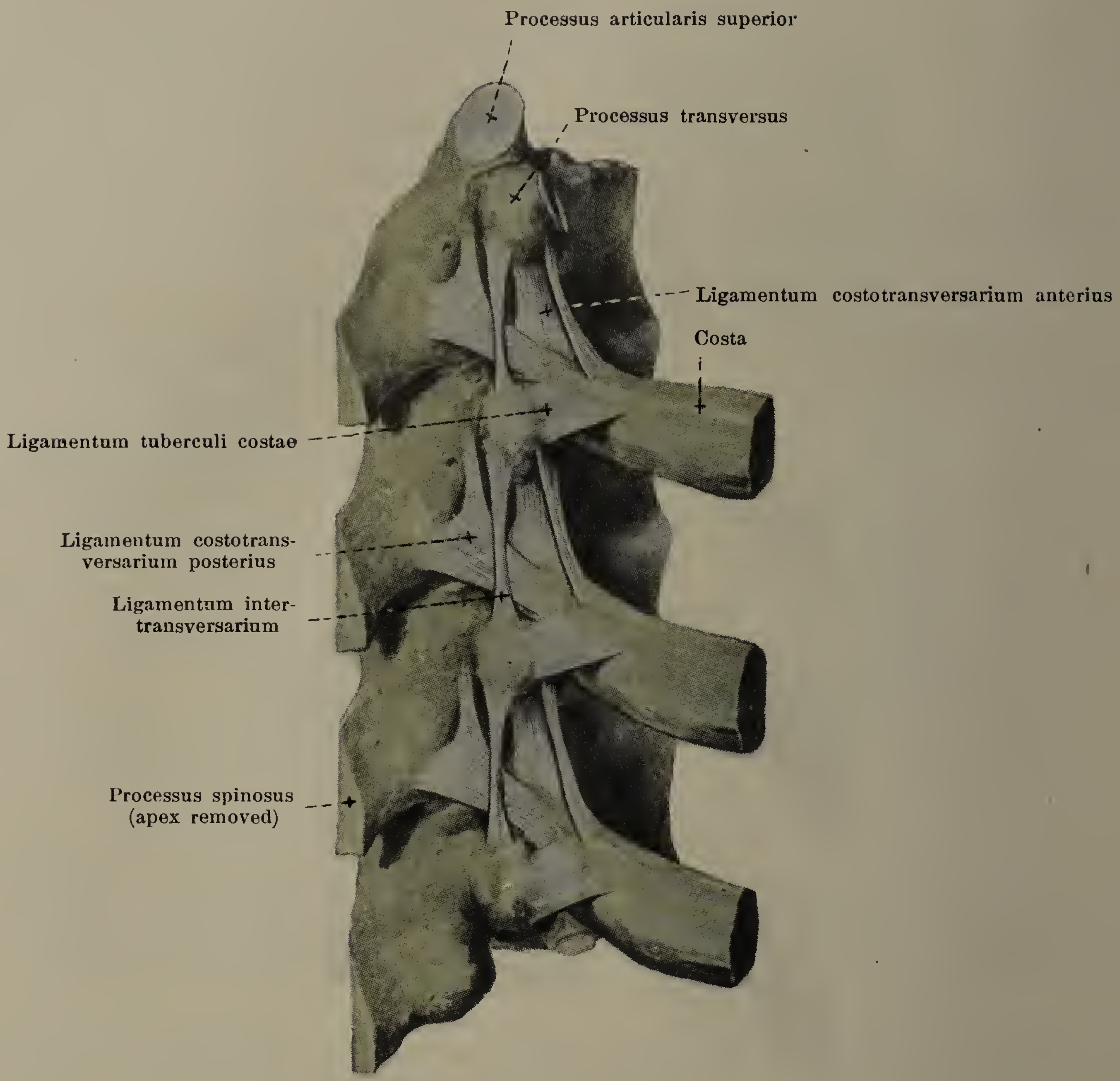
In the ***articulationes capitulorum*** *(articulations between the heads of the ribs and the vertebrae)* (see also Figs. 262, 274 and 276) each capitulum costae lies with its facies articularis in the corresponding foveae costales of the vertebral bodies, so that, for example, the capitulum of the sixth rib rests in the fovea costalis inferior of the fifth thoracic vertebra, in the fovea costalis superior of the sixth thoracic vertebra and in a depression in the intervertebral disc lying between the two. The articular surfaces are for the most part covered by fibrocartilage. On the second to the tenth rib, a *ligamentum capituli costae interarticulare* (O. T. interarticular ligament) extends from each crista capituli to the fibrocartilago intervertebralis, and usually separates two special joint cavities, with their *capsulae articulares* from one another. The first rib is usually, the eleventh and twelfth ribs are ordinarily, united each with one vertebral body only and accordingly possess no ligamentum capituli costae interarticulare and also only one capsula articularis each.


Processus articularis superior
Fovea costalis superior
Fovea costalis transversalis
Ligamentum costotransversarium anterius
Ligamentum intertransversarium
Costa
Ligamentum capituli costae radiatum
Fibrocartilago intervertebralis
Ligamentum longitudinale anterius
Fovea costalis inferior
Processus articularis inferior

274. Ribs and corresponding vertebrae with ligaments, viewed from the right.

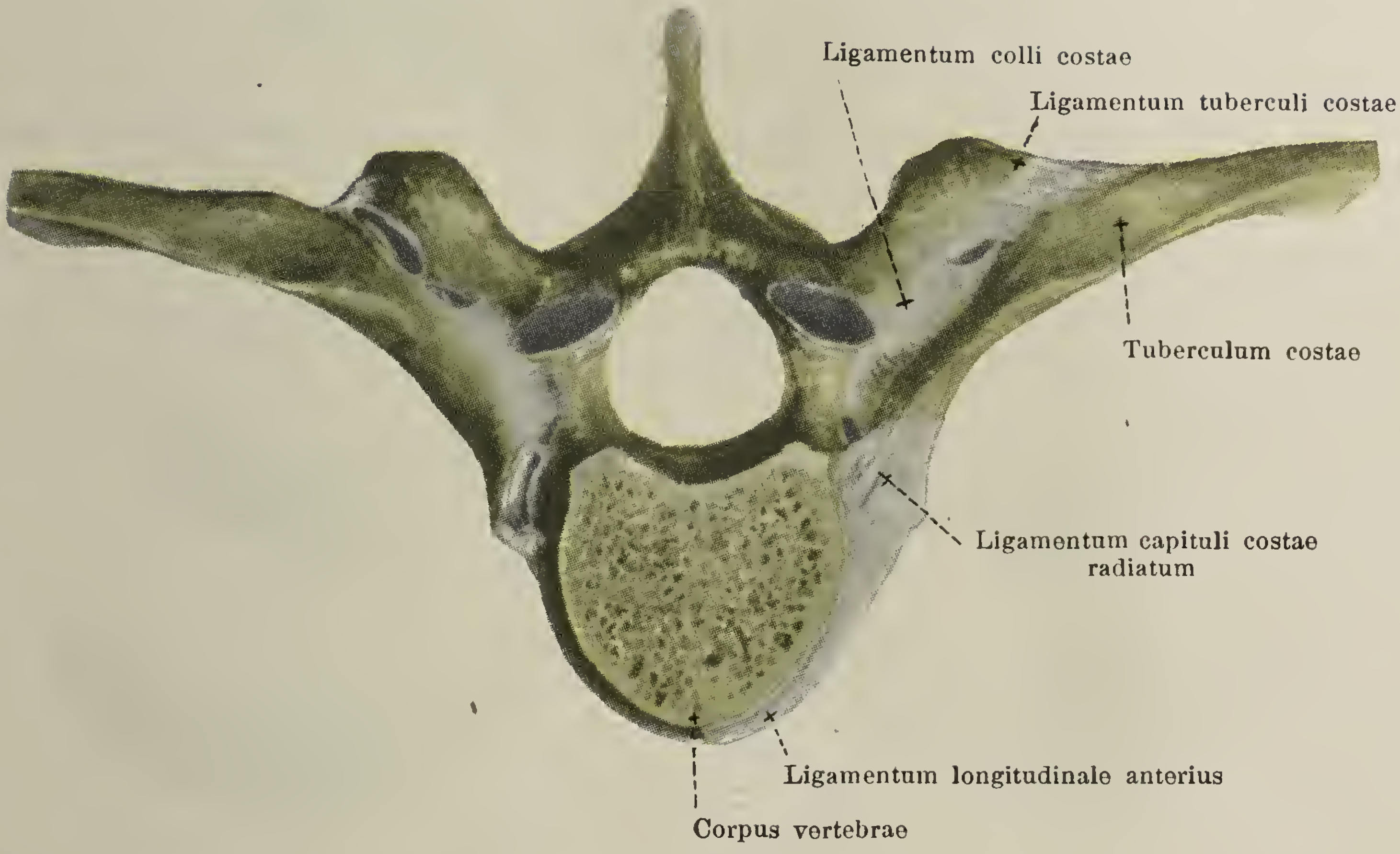
(The right lateral portion of the ligamentum longitudinale anterius has been removed.)

On the anterior surface of each of the **articulationes capitulorum,** the broad flat *ligamentum capituli costae radiatum* (O. T. anterior costovertebral or stellate ligament) (see also Figs. 262 and 276) extends from the head of the rib to the lateral surfaces of the corresponding vertebral bodies and fibrocartilago intervertebralis; the fibres diverge medianward and are partly covered over by the lateral portions of the ligamentum longitudinale anterius. The fibres on the lower ribs running to the lower vertebra are very greatly developed.


Processus articularis superior
Processus transversus
Ligamentum costotransversarium anterius
Costa
Ligamentum tuberculi costae
Ligamentum costotransversarium posterius
Ligamentum intertransversarium
Processus spinosus (apex removed)

275. Ribs and corresponding vertebrae with ligaments, viewed from behind and somewhat from the right.

The **articulationes costotransversariae** (see also Figs. 262, 273, 274 and 276) are formed on the first to the tenth rib always by the apposition of each facies articularis tuberculi costae to the fovea costalis transversalis of the vertebra pertaining to the rib, so that, for example, the tubercle of the sixth rib is connected with the transverse process of the sixth thoracic vertebra. The margins of the cartilaginous joint surfaces are connected by a *capsula articularis.* Extending as a strengthening ligament from the under surface of the next transverse process above is the strong, quadrangular *ligamentum costotransversarium anterius,* which passes obliquely downward and medianward to the crista colli; behind this the feebler, triangular *ligamentum costotransversarium posterius* runs from the root of the processus spinosus and from the root of the processus transversus of the next vertebra above obliquely lateralward and downward to the posterior surface of the collum costae and to the region above the tuberculum costae.

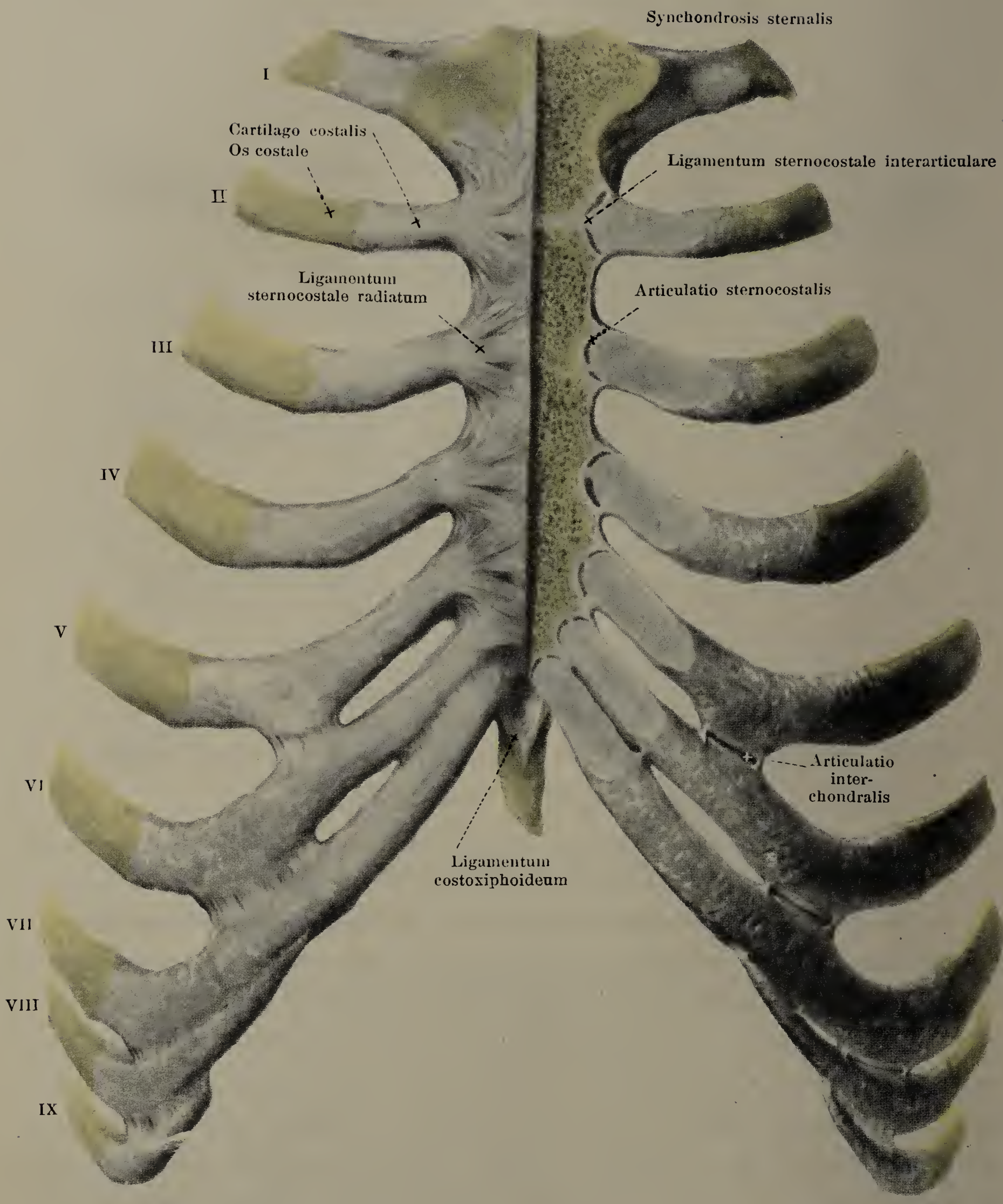

Ligamentum colli costae
Ligamentum tuberculi costae
Tuberculum costae
Ligamentum capituli costae radiatum
Ligamentum longitudinale anterius
Corpus vertebrae

276. Ribs and corresponding vertebrae with ligaments, from above.

(The body of the upper of the two vertebrae connected with the rib has been sawed through transversely. On the right side the joint slits have been opened.)

The following strengthening ligaments of the **articulationes costotransversariae** have yet to be considered: — the *ligamentum tuberculi costae,* which extends as a quadrangular ligament behind the joint from the tip of the processus transversus to the posterior surface of the tuberculum costae (see also Fig. 275), as well as the *ligamentum colli costae.* The latter is short, broad, and stretched out horizontally between the posterior surface of the collum costae and the anterior surface of the processus transversus of the corresponding vertebra. The fibres run obliquely backward and medianward from the rib. This ligament fills the space between the anterior surface of the processus transversus and the posterior surface of the collum costae, the *foramen costotransversarium*, almost completely except for chinks in the anterior and posterior part.

The eleventh and twelfth rib do not touch the processus transversus of the vertebrae concerned; they are joined to it only by weak ligaments, and we find here no joint cavities or capsulae articulares.


Synchondrosis sternalis
I
Cartilago costalis
Os costale
II
Ligamentum sternocostale interarticulare
Ligamentum sternocostale radiatum
Articulatio sternocostalis
III
IV
V
VI
Articulatio interchondralis
Ligamentum costoxiphoideum
VII
VIII
IX

277. Sternum and ribs with ligaments, from in front.

(In the left half the most anterior layer has been removed and the joint slits have been opened; the parts are separated somewhat from one another on the left side.)

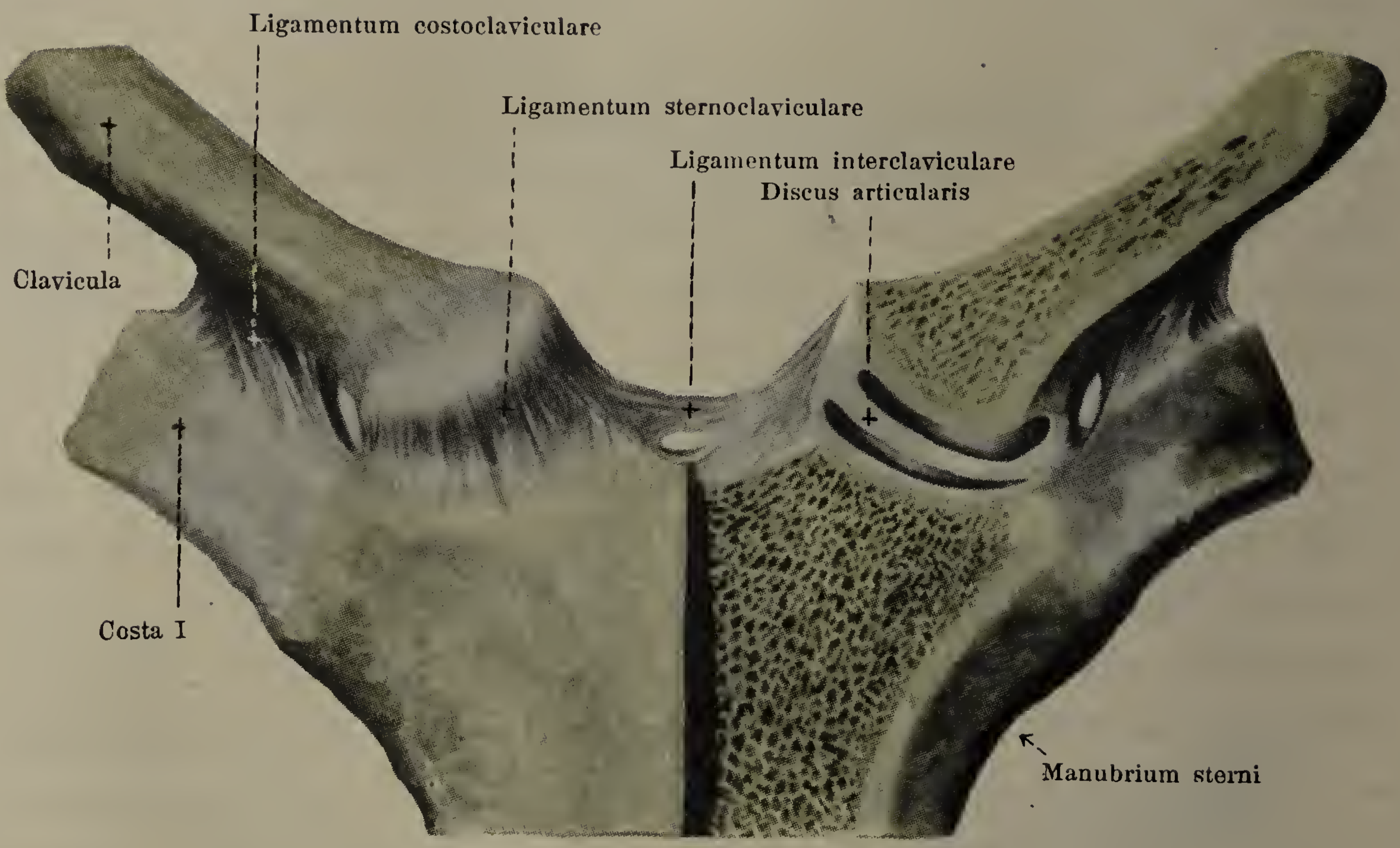
The seven (sometimes eight) upper ribs are connected movably also with the sternum. The anterior extremities of their cartilages are attached directly to the incisurae costales of the sternum and so form the **articulationes sternocostales** *(articulations of the cartilages of the ribs with the sternum)*; the cartilage of the first rib fuses usually directly with the sternum, while for the cartilages of the second to the seventh (sometimes eighth) rib there are present slit-shaped joint cavities and *capsulae articulares.* A fibrocartilaginous layer, the *ligamentum sternocostale interarticulare* (O. T. interarticular chondrosternal ligament), which extends from the medial end of the second costal cartilage to the cartilaginous (or bony) junction of the manubrium with the corpus sterni, there constantly divides this joint into two separate joint cavities. In the other joints there are often similar fibrous strands, which, however, lead usually only to incomplete division of the joint cavities. The joints capsules are strengthened on the anterior surface by strong, on the posterior by weak, *ligamenta sternocostalia radiata* (O. T. anterior and posterior chondrosternal ligaments), which extend from the ends of the costal cartilages, diverging to the sternum; the anterior of these interweave with those of the other side to form a tough layer. This layer, ensheathing the sternum in front and behind, is called the *membrana sterni.*

The eighth and ninth rib are attached usually (see p. 86) each with the anterior end of its cartilage to the cartilage of the next rib above. In these places as well as sometimes at other places on the fifth to the ninth costal cartilage, where contact between the cartilages or cartilaginous processes takes place, small joint-slits and joint capsules are present, the *articulationes interchondrales.*

The anterior extremity of the tenth costal cartilage is united by a loose ligamentous band with the ninth; no such connection of the eleventh and the twelfth rib exists.

For the synchondrosis sternalis (between the manubrium and the corpus) see p. 91.

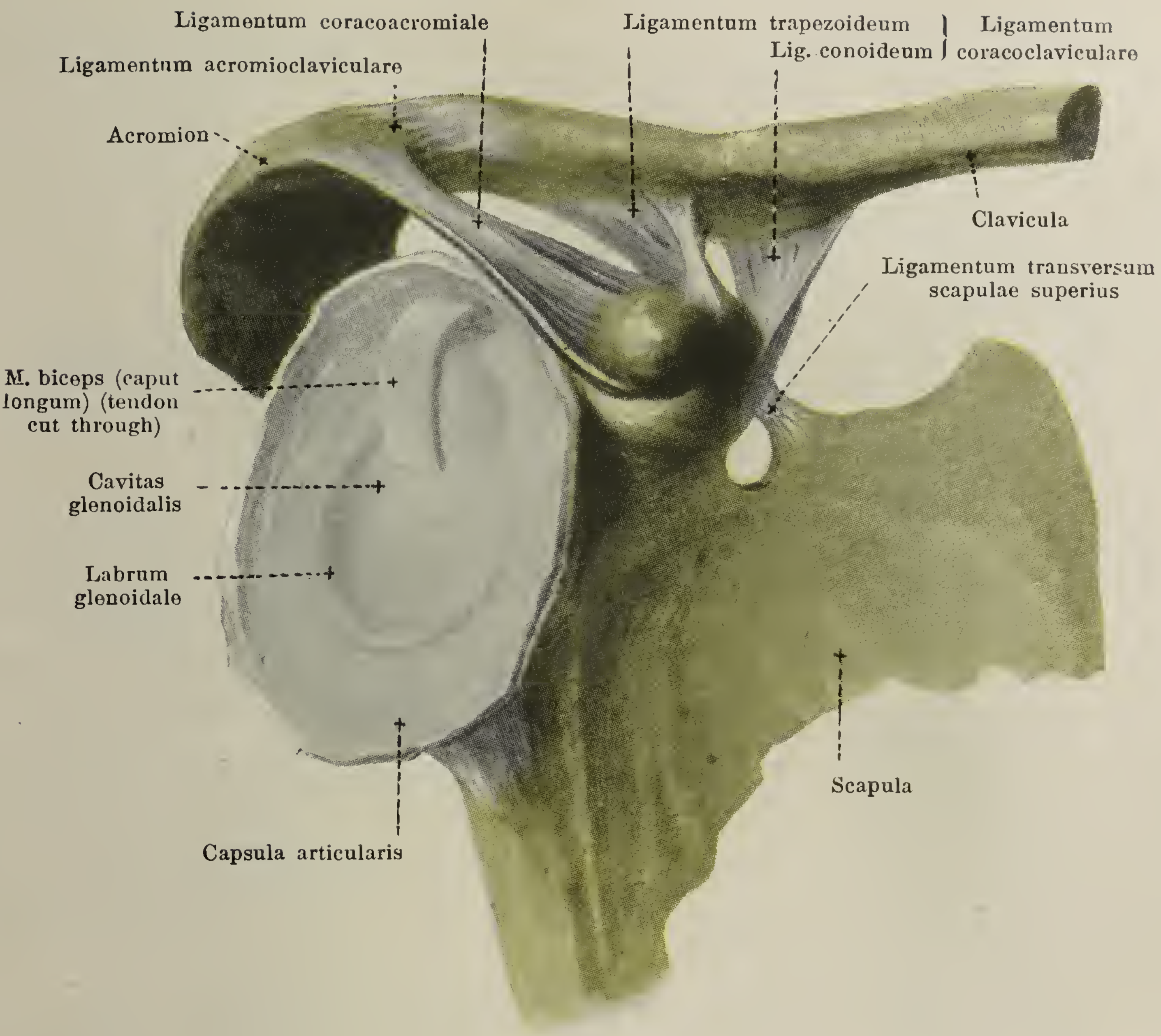
From the lowermost end of the corpus sterni and from the anterior surface of the sixth and seventh costal cartilage strand-like bands go off obliquely medianward to the anterior surface of the processus xiphoideus, the *ligamenta costoxiphoidea* (O. T. chondroxiphoid ligaments). They are connected with the anterior leaf of the vagina musculi recti abdominis.


Ligamentum costoclaviculare
Ligamentum sternoclaviculare
Ligamentum interclaviculare
Discus articularis
Clavicula
Costa I
Manubrium sterni

278. Clavicle, sternum and first rib with ligaments, from in front.

(On the left half the most anterior layer has been removed; the parts forming the joint are somewhat drawn off from another.)

The clavicle can move against the sternum in the **articulatio sternoclavicularis** *(sternoclavicular joint.)* The latter arises from the fact that the extremitas sternalis claviculae with its facies articularis sternalis, covered with cartilage, lies in the incisura clavicularis sterni which is also covered with cartilage, the two being separated only by the *discus articularis* (O. T. interarticular fibrocartilage) which is seldom perforated; the latter is thickened above, medianward and behind, and separates two special joint cavities with *capsulae articulares* from one another. The discus articularis and the cartilaginous coverings consist of fibrocartilage. On the anterior surfaces of the joint the broad *ligamentum sternoclaviculare* extends with diverging fibres from the clavicle down to the sternum; similar fibres run also along the back. In addition, the rounded, unpaired *ligamentum interclaviculare,* concave above, stretches out between the medial extremities of the two clavicles over the incisura jugularis sterni. The fibres of this ligament arise partly from the discus. The ligament is situated nearer the posterior surface of the sternum and is connected with the *incisura jugularis* by loose tissue. The *ligamentum costoclaviculare* (O. T. rhomboid ligament), a very powerful ligament, consisting of two layers, goes from the upper margin of the first costal cartilage to the tuberositas costalis claviculae; there is always a bursa between the two layers.


Ligamentum coracoacromiale
Ligamentum acromioclaviculare
Acromion
Ligamentum trapezoideum
Lig. conoideum
Ligamentum coracoclaviculare
Clavicula
Ligamentum transversum scapulae superius
M. biceps (caput longum) (tendon cut through)
Cavitas glenoidalis
Labrum glenoidale
Scapula
Capsula articularis

279. Right shoulder girdle with ligaments,

from without and somewhat from in front.

(The medial half of the clavicle has been sawed off. The shoulder joint has been opened and the head of the humerus removed. Of the shoulder blade only the lateral portion has been drawn.)

The clavicle is movably united with the shoulder blade by the **articulatio acromioclavicularis** in which the facies articularis acromialis claviculae runs on the facies articularis acromii (rarely with intercalation of a disc of fibrocartilage, *discus articularis).* From the margins of the joint surfaces stretches out a *capsula articularis*, strengthened on the upper surface by the broad *ligamentum acromioclaviculare.*

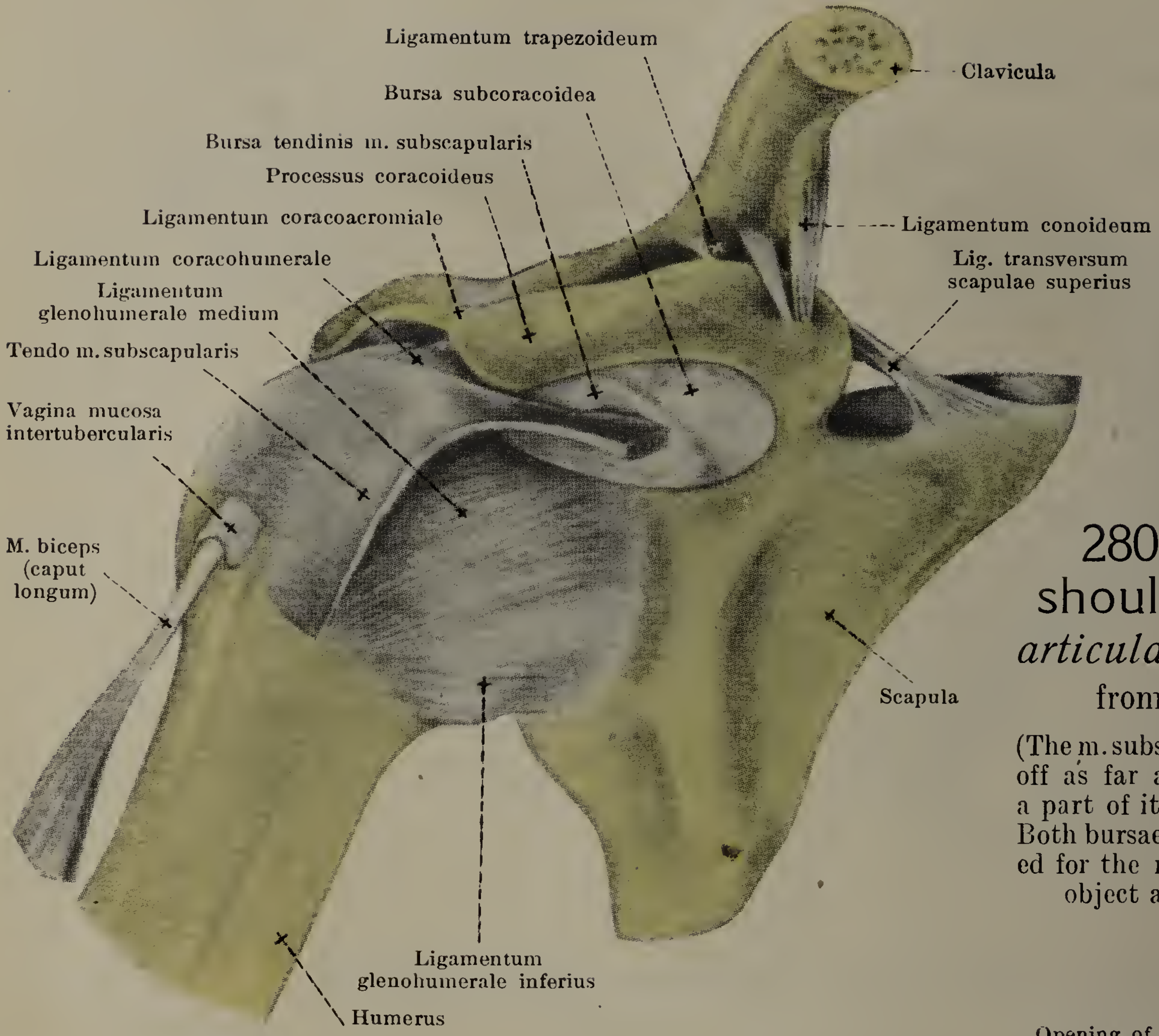
Between the tuberositas coracoidea claviculae and the upper surface of the processus coracoideus scapulae extends the broad, powerful *ligamentum coracoclaviculare;* its anterior lateral, quadrangular part is called the *ligamentum trapezoideum*, its posterior medial, triangular part, broader above, more apical below, the *ligamentum conoideum;* between the two there is often a bursa, *bursa ligamenti coracoclavicularis* (see page 318).

The three **ligaments of the shoulder blade** extend between segments of bone which are not movable upon one another; they accordingly serve only as a supplement of the bony structure.

The *ligamentum coracoacromiale (coracoacromial ligament)* is strong, broad, oblong-quadrangular and extends above the shoulder joint from the anterior surface of the acromion to the posterior surface of the processus coracoideus.

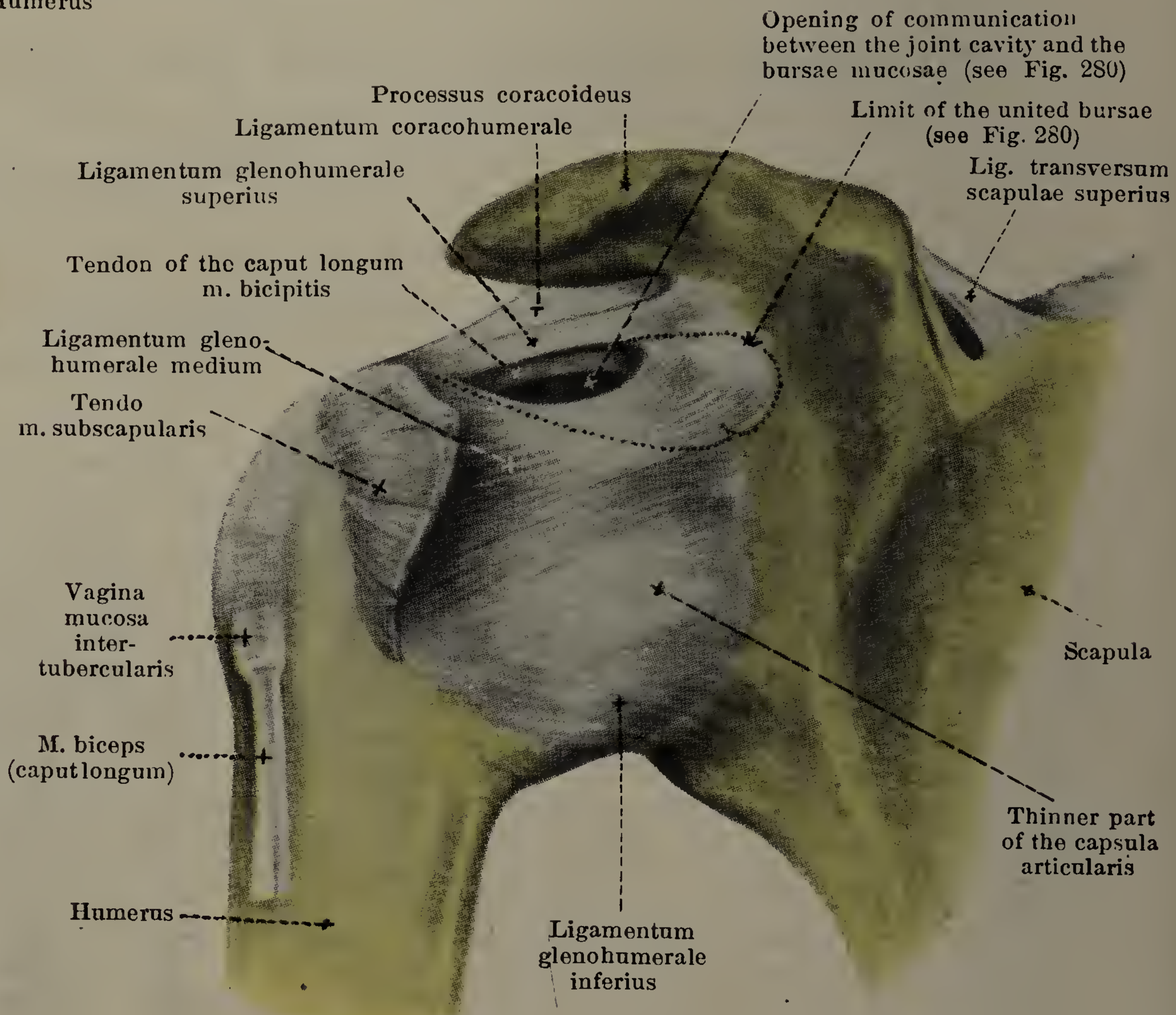
The *ligamentum transversum scapulae superius* (see also Figs. 280, 280a and 282) is thin and flat; it is stretched out over the incisura scapulae and transforms this into a foramen through which pass the v. transversa scapulae and the n. suprascapularis (the a. transversa scapulae generally runs over the ligament).

The *ligamentum transversum scapulae inferius* (see Fig. 281) is thin and round; it extends from the lateral edge of the spina scapulae to the posterior margin of the cavitas glenoidalis, over the collum scapulae. Through the space between the ligament and the bone runs the a. transversa scapulae and the n. suprascapularis.


Ligamentum trapezoideum
Bursa subcoracoidea
Bursa tendinis m. subscapularis
Processus coracoideus
Ligamentum coracoacromiale
Ligamentum coracohumerale
Ligamentum glenohumerale medium
Tendo m. subscapularis
Vagina mucosa intertubercularis
M. biceps (caput longum)
Clavicula
Ligamentum conoideum
Lig. transversum scapulae superius
Scapula
Ligamentum glenohumerale inferius
Humerus

280. Right shoulder joint, *articulatio humeri,* from in front.

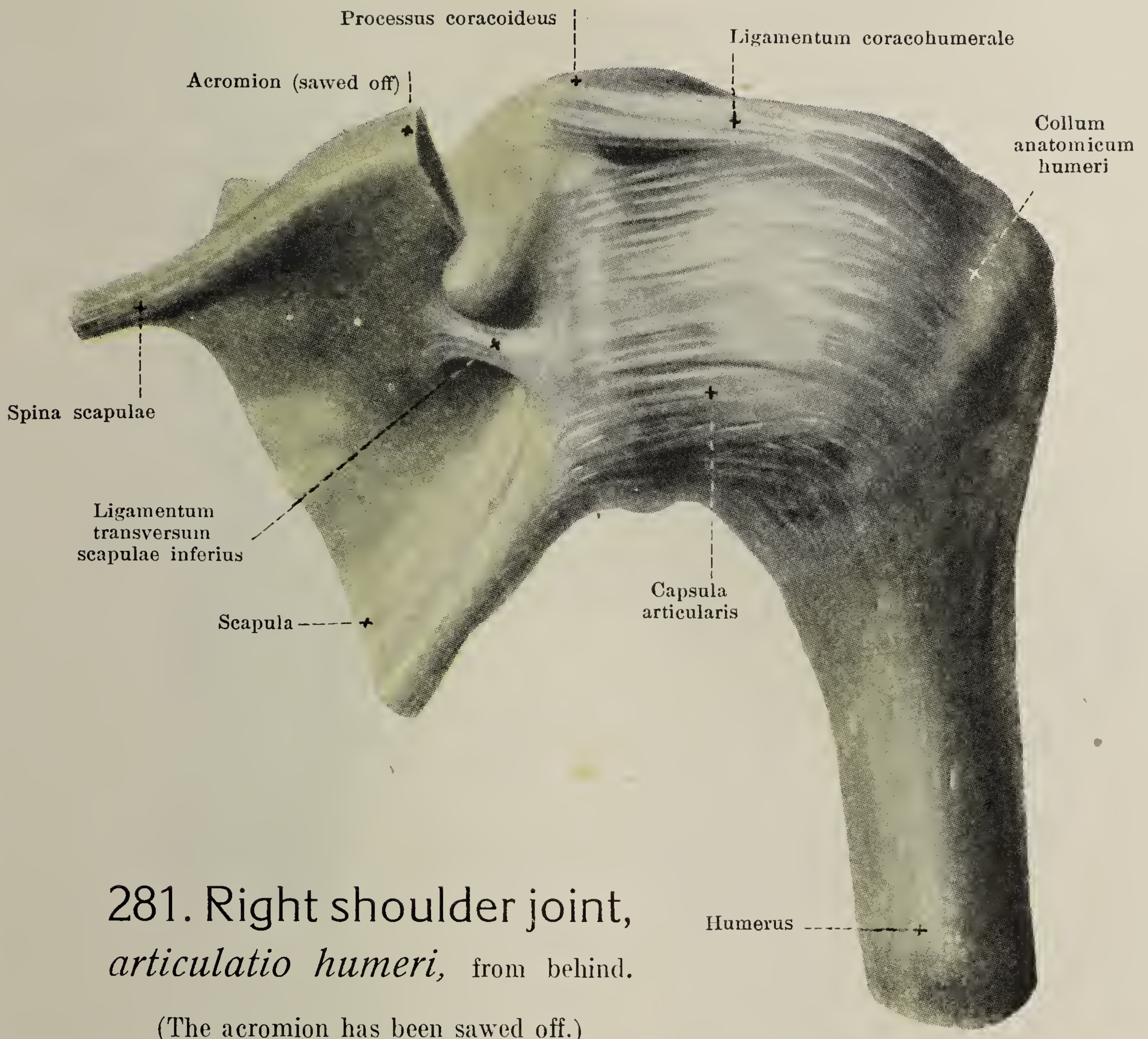
(The m. subscapularis is taken off as far as its tendon and a part of its muscular mass. Both bursae which were united for the most part in this object are extended.)


Opening of communication between the joint cavity and the bursae mucosae (see Fig. 280)
Processus coracoideus
Ligamentum coracohumerale
Limit of the united bursae (see Fig. 280)
Lig. transversum scapulae superius
Ligamentum glenohumerale superius
Tendon of the caput longum m. bicipitis
Ligamentum glenohumerale medium
Tendo m. subscapularis
Vagina mucosa intertubercularis
M. biceps (caput longum)
Humerus
Scapula
Thinner part of the capsula articularis
Ligamentum glenohumerale inferius

280a. Right shoulder joint, *articulatio humeri,* from in front.

(The clavicula is removed completely, the m. subscapularis as far as its tendon. The united bursae are taken off completely; their extent is shown by a dotted line.)

The Figs. 280 and 280a are taken from the same object.



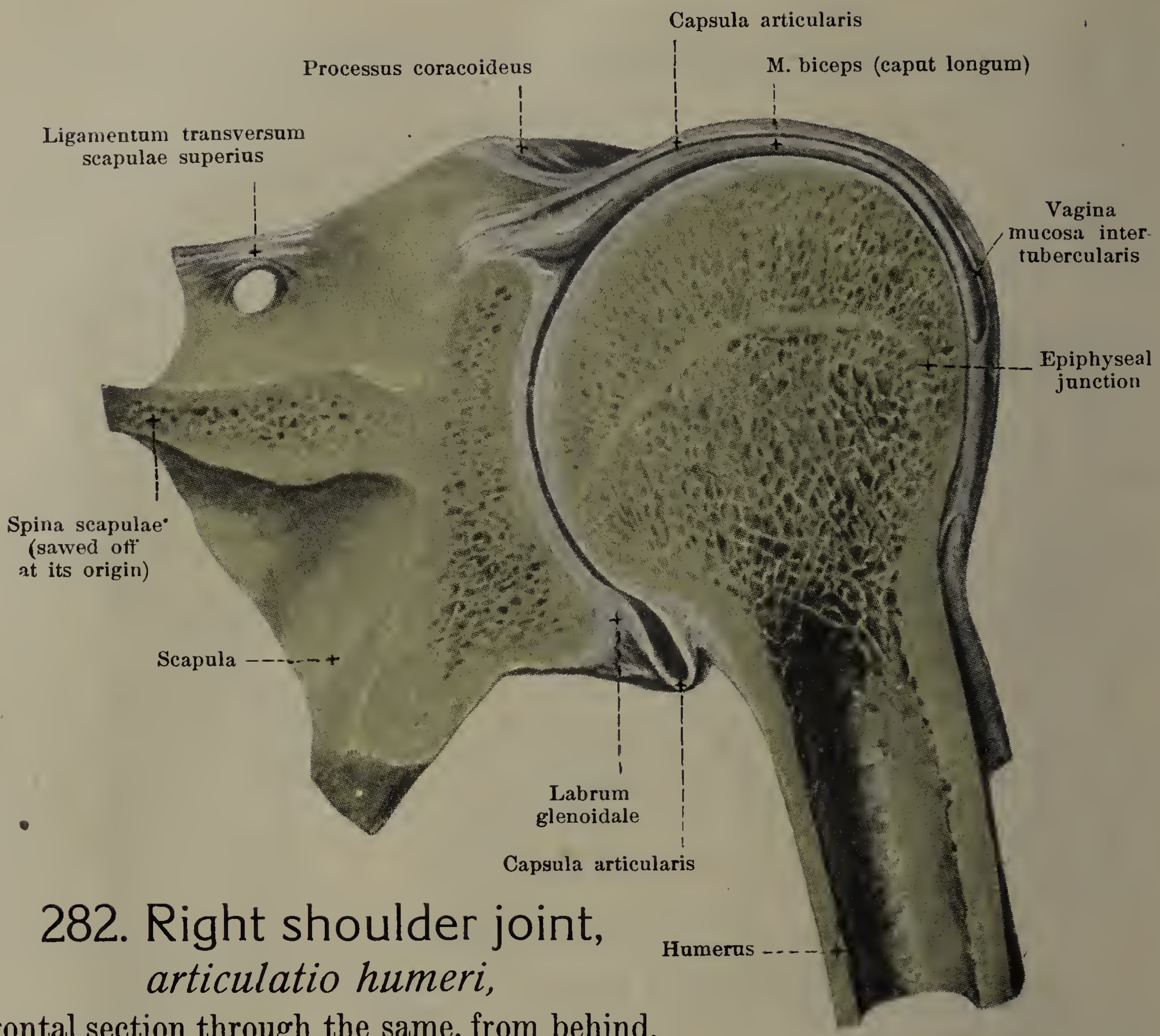
281. Right shoulder joint, *articulatio humeri,* from behind.

(The acromion has been sawed off.)

The upper arm moves against the shoulder blade in the **articulatio humeri** *(shoulder joint)* (see also Figs. 279. 280, 280a and 282), which arises from the fact that the caput humeri moves upon the cavitas glenoidalis scapulae. The articular surface of the shoulder blade is enlarged by means of a connective tissue ring, *labrum glenoidale* (O. T. glenoid ligament), which is attached to the margin of the cavitas glenoidalis. From the outer side of this fibrous projection a wide and loose *capsula articularis* extends to the collum anatomicum humeri and bridges over the upper end of the sulcus intertubercularis. The mm. subscapularis, supraspinatus, infraspinatus and teres minor, running close by the joint, partly are firmly attached to the capsule near their insertions to the humerus. The stratum fibrosum of the capsule consists essentially of laterally directed fibre bands.

As an especial strengthening ligament is mentioned the *ligamentum coracohumerale* (see also Figs. 280 and 280a). This arises from the lateral border and from the basis of the processus coracoideus below the ligamentum coracoacromiale, is there separated from the capsule by loose tissue, but then sinks into the capsule and goes to the tuberculum majus and minus as well as to a fibrous mass which bridges over the sulcus intertubercularis.

The anterior part of the capsule is strengthened by three very variable fibrous bands which arise from the labrum glenoidale, namely (see Figs. 280 and 280a); *Ligamentum glenohumerale superius*, small, comes from the upper end of the cavitas glenoidalis and is attached together with the ligamentum coracohumerale close above the tuberculum minus. *Ligamentum glenohumerale medium*, very strong, arises close below the former, is below only indistinctly bordered and diverges to the tuberculum minus. *Ligamentum glenohumerale inferius* comes broadly from the lower part of the anterior border of the cavitas glenoidalis and goes, only undistinctly limited, to the collum chirurgicum; it is separated frequently from the former by a thinner part of the capsule.
]



282. Right shoulder joint, *articulatio humeri,* frontal section through the same, from behind.

(The vagina mucosa intertubercularis has not been opened in its whole length.)

Articulatio humeri (continued) (see also Figs. 280, 280a and 281). The capsula articularis presents as regular bulging the *vagina mucosa intertubercularis* (see also Figs. 280 and 280a). It surrounds the tendon of the caput longum m. bicipitis as a tubular cylindrical canal, is in free communication at its upper extremity with the joint cavity and lies close to the bone in the region of the sulcus intertubercularis which is covered with cartilage above; it ends in the form of a blind sac in the region of the collum chirurgicum where the stratum synoviale of the capsule is reflected upon the tendon of the m. biceps, covering over the part of the same as it runs inside the joint cavity.

In three quarters of the cases exists a mucous bursa, *bursa subcoracoidea* (see Figs. 280 and 280a), which embraces the m. subscapularis from above in such a way, that also a larger part of the dorsal and a smaller part of the ventral surface of the muscle borders on it. It reaches before the lig. glenohumerale medium and the collum scapulae often as far as in the concavity of the root of the proc. coracoideus; as a rule it communicates between the ligg. glenohumeralia superius and medium by an oblong slit with the joint cavity. Frequently it is united with the following bursa by a opening of different size.

Nearly just so frequent is an oblong *bursa tendinis m. subscapularis* (see Figs. 280 and 280a) which lies like a groove on the upper edge of the tendon of the m. subscapularis as well as on a strip of its ventral and dorsal surface; it may extend near the former far medianward. In the half of the cases it is separated from the joint cavity; in the other cases it is united with it between the ligamenta glenohumerale superius and medium.

In almost half of the cases there is between the dorsal surface of the m. subscapularis and the capsula articularis a bursa *(bursa infracoracoidea lateralis)* (not drawn) which connects always between a—somewhat smaller—lig. glenohumerale medium and the lig. glenohumerale inferius with the joint cavity and which may reach before the collum scapulae to the root of the proc. coracoideus.

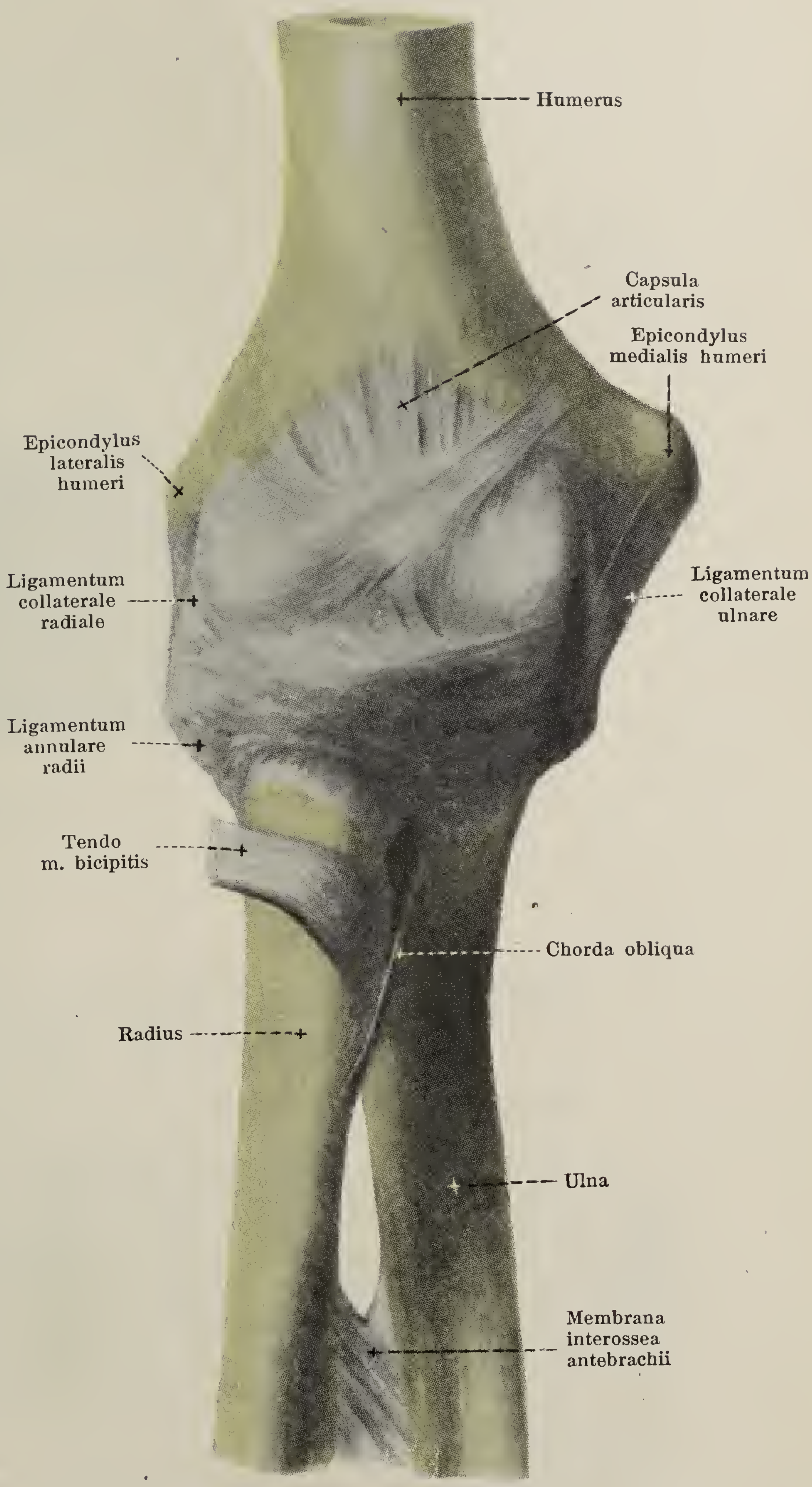
In this region are observed besides—more rarely—some little other bursae.

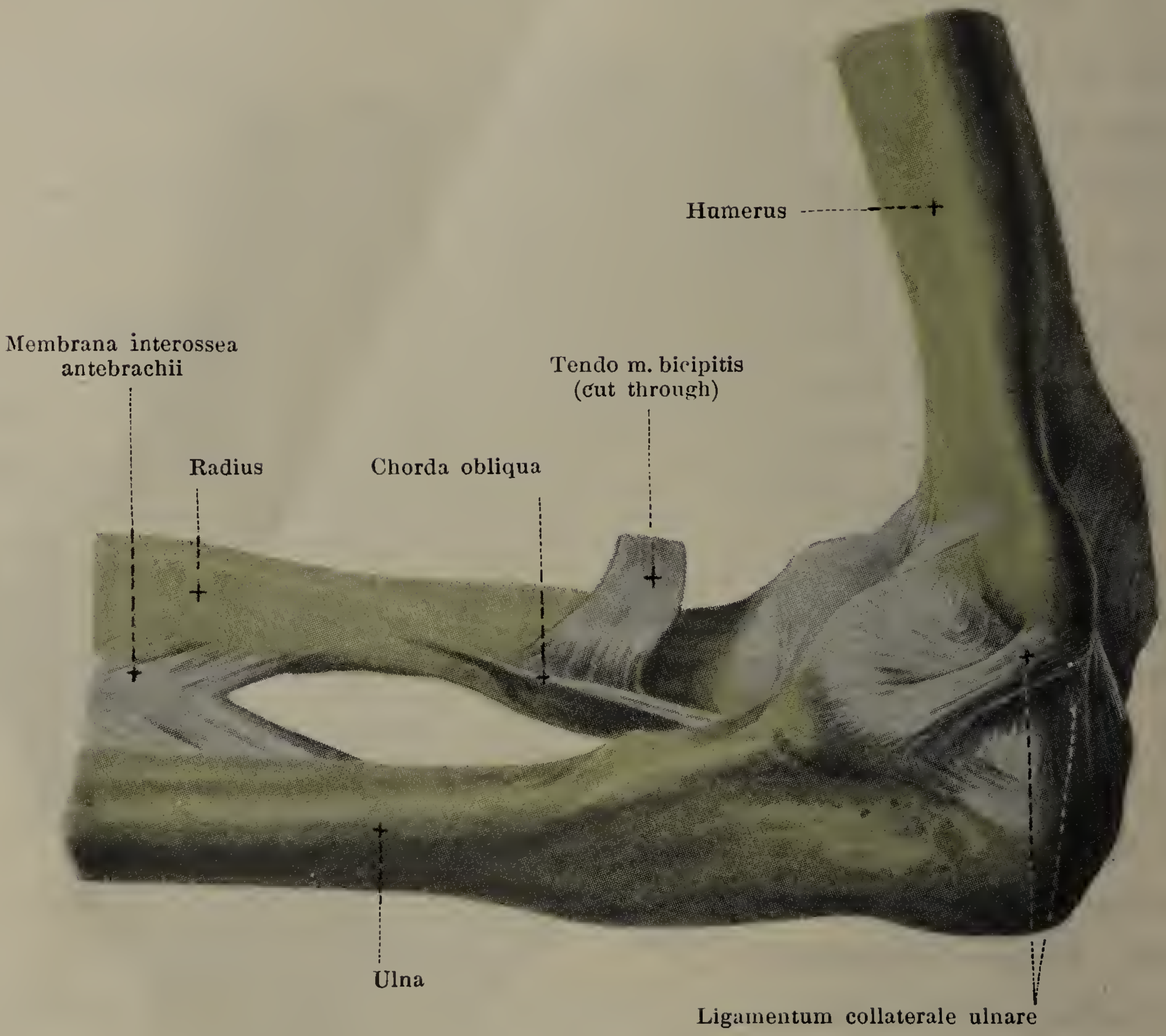
283.

Right elbow joint,

articulatio cubiti,
extended in supination of the hand, from in front.

The articulation between the humerus and the bones of the forearm is the **articulatio cubiti** *(elbow joint)* (see also Figs. 284 to 288). Here three different joints are included in one common *capsula articularis:* (1) the incisura semilunaris ulnae glides upon the trochlea humeri *(articulatio humeroulnaris)*, (2) the fovea capituli radii rotates on the capitulum humeri (*articulatio humeroradialis*), (3) the circumferentia articularis radii moves in the incisura radialis ulnae *(articulatio radioulnaris proximalis)*. The articulatio humeroulnaris takes part in the movements between the upper arm and the forearm only, while the articulatio radioulnaris proximalis serves exclusively for the movements between the two bones of the forearm; the articulatio humeroradialis on the other hand, takes part in both movements.


Humerus
Capsula articularis
Epicondylus medialis humeri
Epicondylus lateralis humeri
Ligamentum collaterale radiale
Ligamentum collaterale ulnare
Ligamentum annulare radii
Tendo m. bicipitis
Chorda obliqua
Radius
Ulna
Membrana interossea antebrachii


Humerus
Membrana interossea antebrachii
Tendo m. bicipitis (cut through)
Radius
Chorda obliqua
Ulna
Ligamentum collaterale ulnare

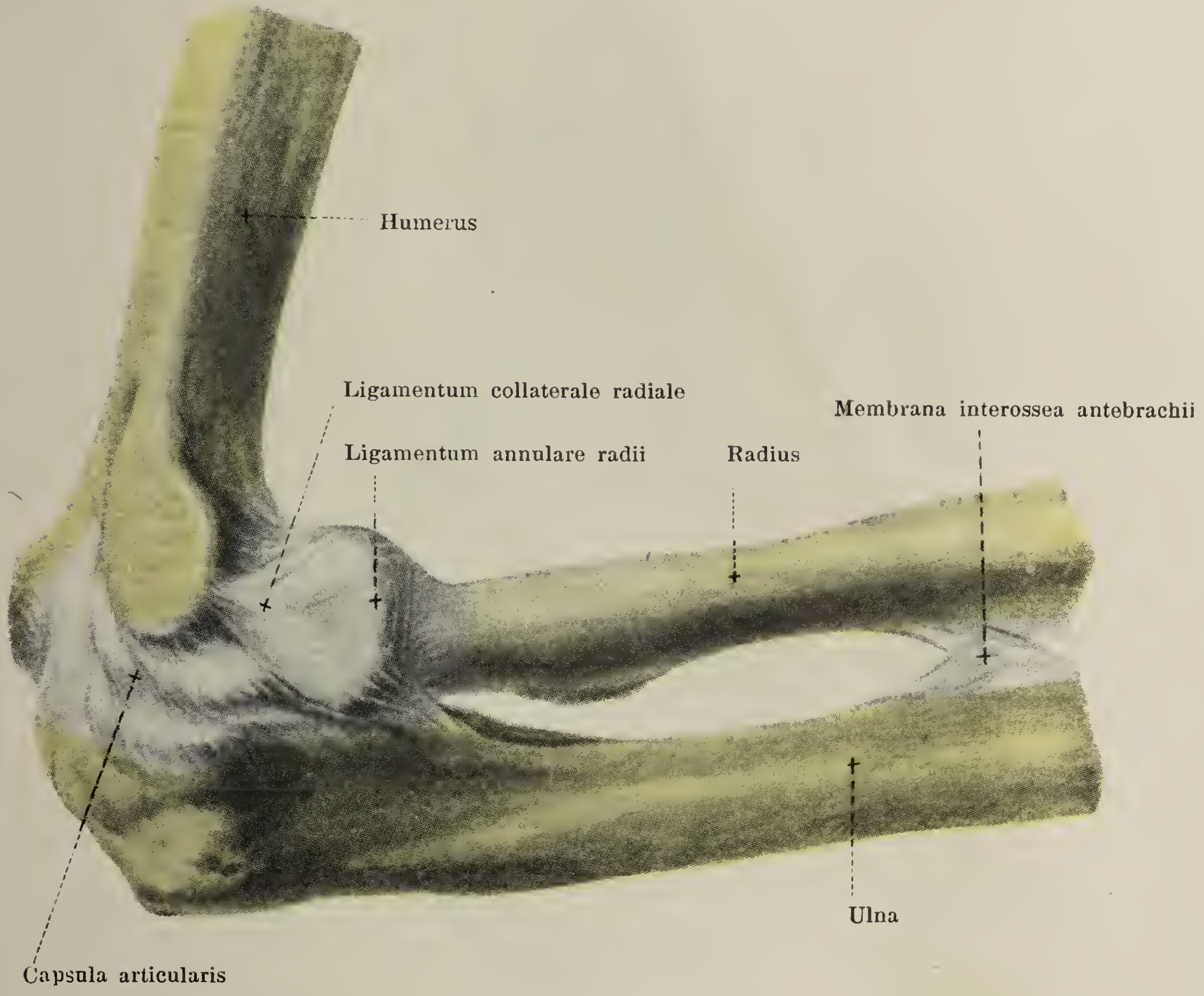
284. Right elbow joint, *articulatio cubiti,*

flexed at a right angle, from the ulnar side.

The hand is in an intermediate position between pronation and supination.

Articulatio cubiti (continued) (see also Figs. 283 and 285—288). The *capsula articularis* is tolerably wide and proceeds from the humerus in front and behind in a line convex above. This place of origin lies in the middle in front close above the fossa coronoidea (see note on Fig. 287) and fossa radialis, behind in the upper part of the fossa olecrani; on the sides it runs distalward from the two epicondyli. On the ulna the capsule is always attached in the whole circumference of the incisura semilunaris and incisura radialis beyond the margin of the surfaces covered with cartilage; to the radius it is fastened around the collum radii, about in the middle between the lower margin of the capitulum and the tuberositas radii. The narrow bulging of the capsule between the incisura radialis ulnae and the circumferentia articularis radii extending distalward is called the *recessus sacciformis.*

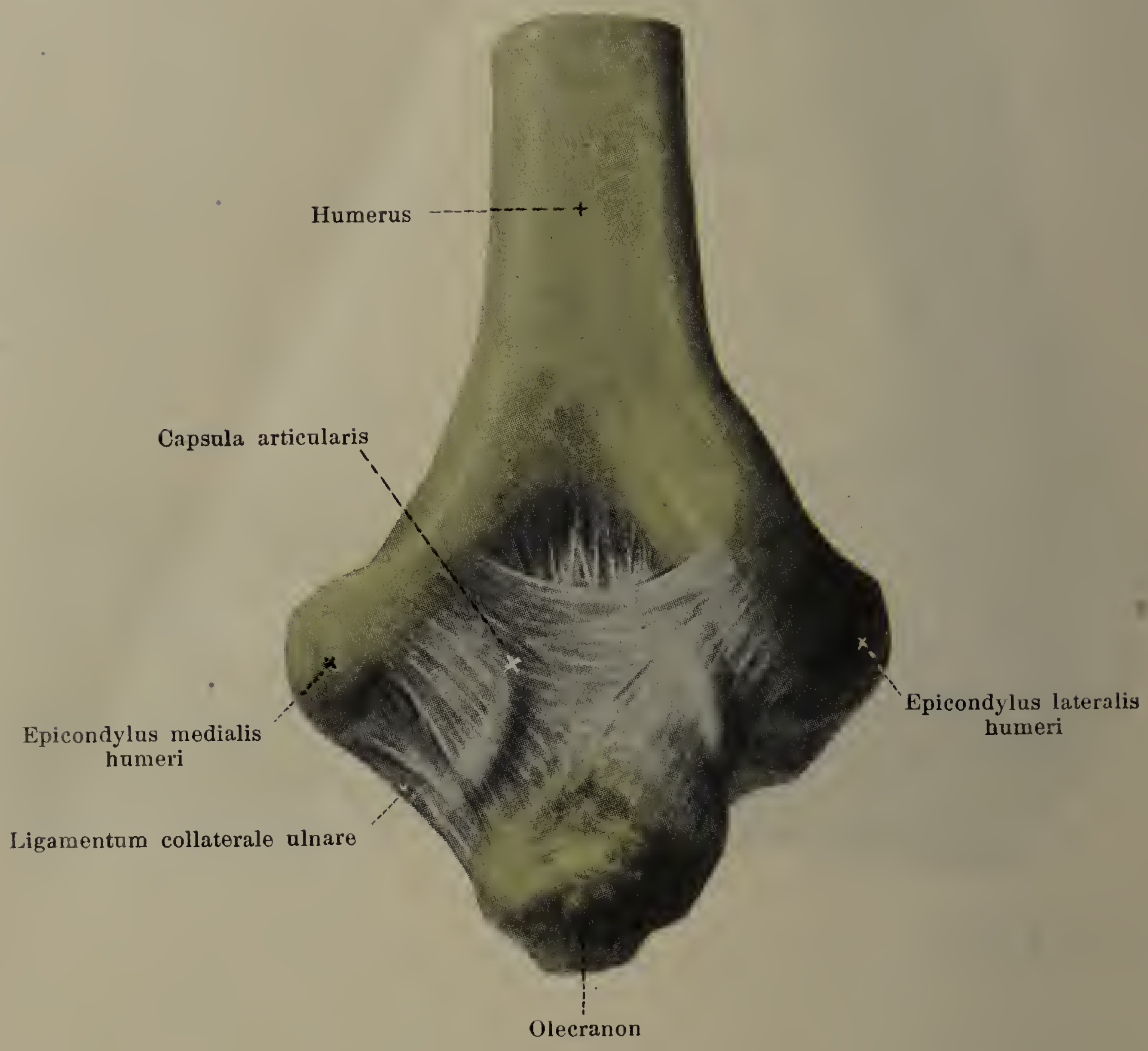
The powerful, flat, triangular *ligamentum collaterale ulnare* (O. T. internal lateral ligament) (see also Figs. 283 and 286) is to be mentioned as an especial strengthened ligament on the ulnar side; it extends from the epicondylus medialis humeri, its fibres diverging to the ulnar margin of the incisura semilunaris ulnae; its anterior part is usually in contact with a thick fibrous band, which extends to the basis of the processus coronoideus.


Humerus
Ligamentum collaterale radiale
Ligamentum annulare radii
Radius
Membrana interossea antebrachii
Ulna
Capsula articularis

285. Right elbow joint, *articulatio cubiti,*
flexed at a right angle, from the radial side.

The hand is in an intermediate position between pronation and supination.

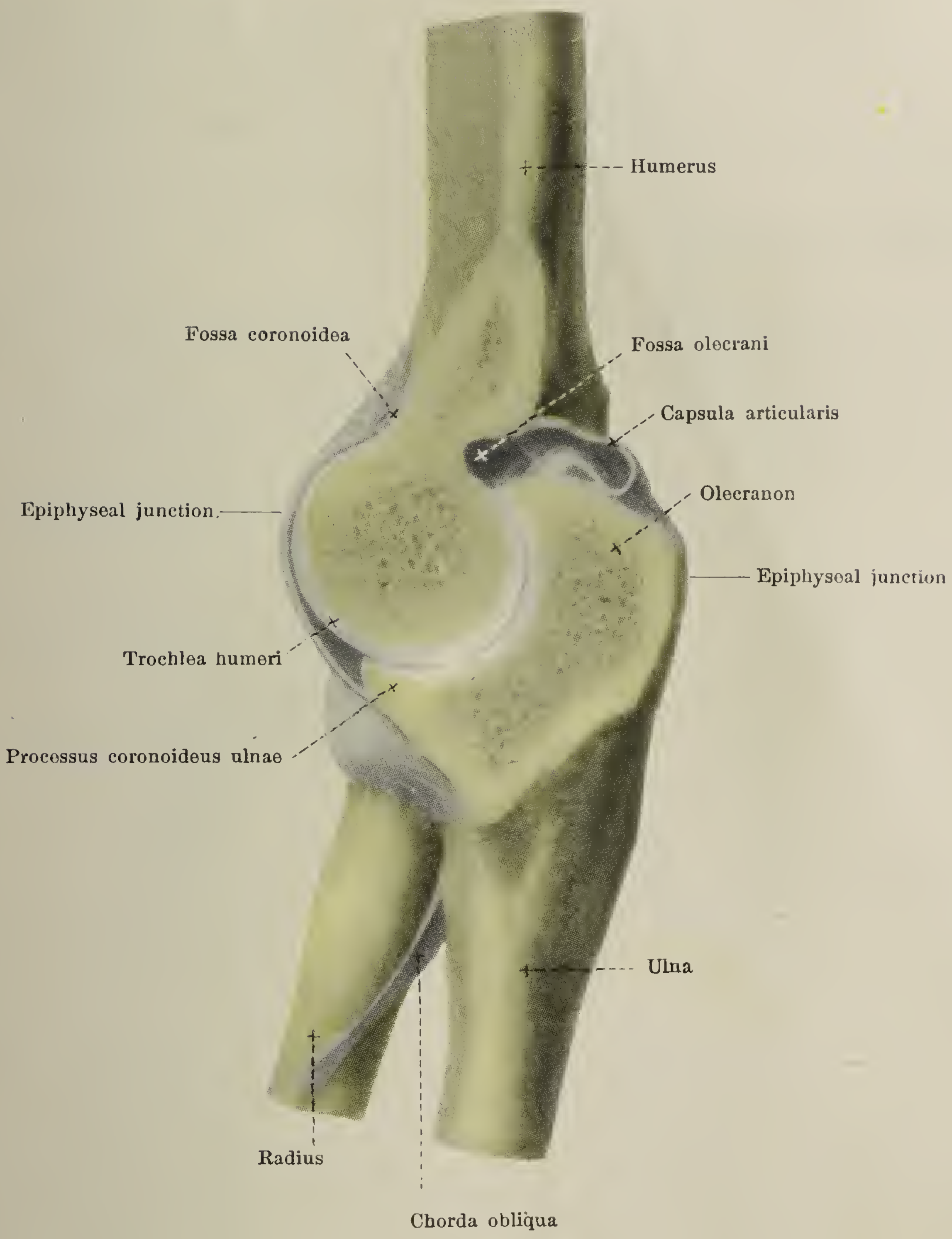
Articulatio cubiti (continued) (see also Figs. 283, 284 and 286—288). It possesses as a second strengthening ligament on its radial side the *ligamentum collaterale radiale* (O. T. external lateral ligament). This arises as a strong bundle on the epicondylus lateralis humeri and divides into two diverging fibre bands of which one goes in front of, the other behind the capitulum radii; they are attached also to the ulna partly in front of the incisura radialis, partly behind it and to the radial margin of the incisura semilunaris; distalward they reach as far as the level of the collum radii. The space between the diverging limbs of this ligament is filled up by fibres, which come from the epicondylus and are inserted distalward in the ligamentum annulare radii (see below), and also by those which surround the capitulum and collum radii; the latter circular fibre bands which partially unite with the limbs mentioned, and partially are fastened separately to the ulna in front and behind the incisura radialis, are most markedly developed at their distal part and are grouped together especially under the name *ligamentum annulare radii* (O. T. orbicular ligament) (see also Fig. 288), but they are only artificially, not sharply, separable from the others.


Humerus
Capsula articularis
Epicondylus medialis humeri
Ligamentum collaterale ulnare
Epicondylus lateralis humeri
Olecranon

286. Right elbow joint, *articulatio cubiti,*
from behind.

(The forearm is flexed at a right angle on the upper arm.)

The *capsula articularis* of the **articulatio cubiti** (see also Figs. 283—285 and 287) reaches on the upper arm behind, in the middle as far as the upper part of the fossa olecrani, on the sides as far as the lower part of the epicondylus medialis and lateralis. Especial strengthening ligaments in the posterior wall of the fibrous capsule will not be described. The upper part of the fossa olecrani contains a thick mass of fat close to the capsule between it and the tendon of the m. triceps brachii.



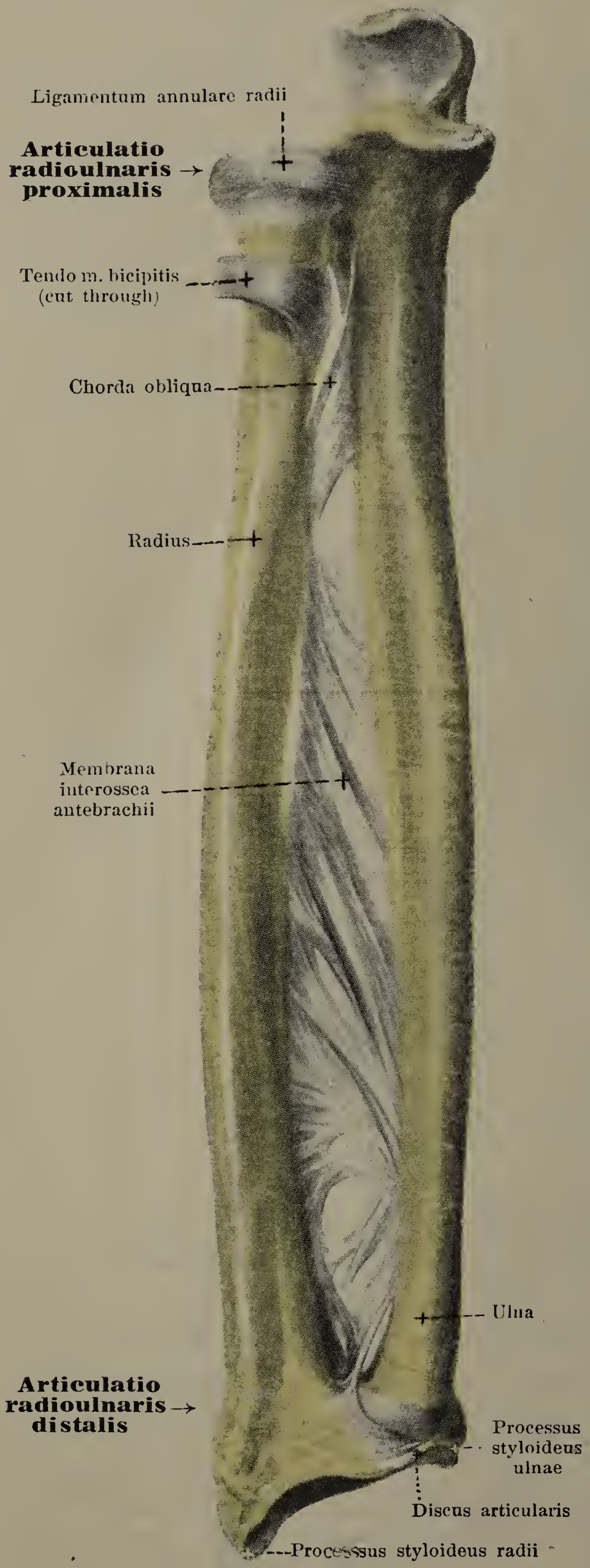
287. Right elbow joint, *articulatio cubiti,*

cut through at right angles to the axis of the trochlea humeri, from the ulnar side.

The hand is in an intermediate position between pronation and supination.

(The joint cavity on the anterior surface is not struck at the spot in which extends furthest upward; the latter corresponds about to the place where the dotted line marked „fossa coronoidea“ meets the bone.)

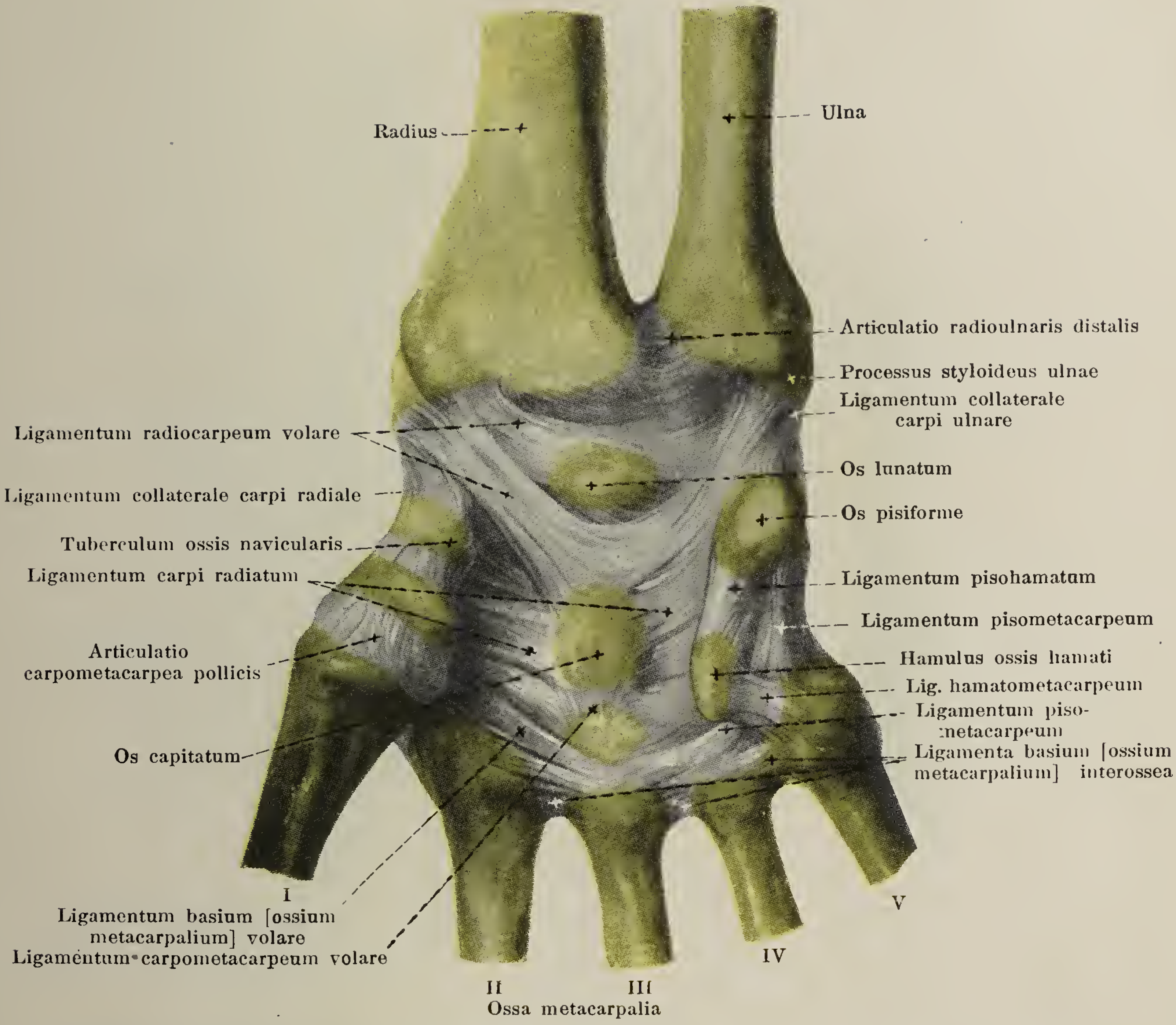
In the **articulatio cubiti** the olecranon ulnae comes to lie in the fossa olecrani humeri when the forearm is extended; when the forearm is flexed, on the contrary, the processus coronoideus ulnae enters the fossa coronoidea humeri, and the capitulum radii enters the fossa radialis. The movements of extension are for the most part, those of flexion frequently checked by the fitting in of the olecranon ulnae or processus coronoideus ulnae respectively into the corresponding depressions of the humerus.


Ligamentum annulare radii
Articulatio radioulnaris proximalis
Tendo m. bicipitis (cut through)
Chorda obliqua
Radius
Membrana interossea antebrachii
Ulna
Articulatio radioulnaris distalis
Processus styloideus ulnae
Discus articularis
Processus styloideus radii

288. Bones of the right forearm with ligaments,

in supination of the hand, from the volar surface.

The joint union between the two bones of the forearm, the **articulatio radioulnaris,** is divisible spatially into two portions; these are the *articulatio radioulnaris proximalis* (O. T. superior radioulnar articulation) between the circumferentia articularis of the capitulum radii and the incisura radialis ulnae (see p. 199) and the *articulatio radioulnaris distalis* (O. T. inferior radioulnar articulation) between the incisura ulnaris radii and the circumferentia articularis of the capitulum ulnae. The latter joint (see also Figs. 289 to 291) is surrounded by a loose *capsula articularis.* This arises on the radius and ulna from the margin of the cartilaginous surfaces and fuses distalward with the margin of the *discus articularis,* a triangular connective tissue plate, often perforated by a slit or hole; this disc has a broad attachment to the ulnar margin of the incisura ulnaris radii and is fastened by means of a short fibrous cord to the tip of the processus styloideus ulnae (see also Fig. 291). The blind-sac-like bulging of the joint capsule extending proximalward between the circumferentia articularis of the capitulum ulnae and the incisura ulnaris radii is called the *recessus sacciformis* (see Fig. 291). The articulationes radioulnares proximalis et distalis, in a mechanical sense, form together one joint. The space between the two bones of the forearm is almost completely filled up by the *membrana interossea antebrachii (interosseous membrane).* This powerful fibrous sheet is stretched out between the cristae interosseae of the radius and of the ulna, is separated proximalward by a large, distalward by a narrow space from the corresponding joint, and possesses several irregular openings for the passage of vessels and nerves; the fibre bands run in the main obliquely and extend from the radius distalward toward the ulna. In addition the *chorda obliqua* (O. T. oblique ligament) (see also Figs. 283 and 284) extends as a thin rounded fibrous band from the region of the tuberositas ulnae obliquely downward to the region of the tuberositas radii.


Radius
Ulna
Articulatio radioulnaris distalis
Processus styloideus ulnae
Ligamentum collaterale carpi ulnare
Ligamentum radiocarpeum volare
Ligamentum collaterale carpi radiale
Os lunatum
Os pisiforme
Tuberculum ossis navicularis
Ligamentum carpi radiatum
Ligamentum pisohamatum
Ligamentum pisometacarpeum
Articulatio carpometacarpea pollicis
Hamulus ossis hamati
Lig. hamatometacarpeum
Ligamentum pisometacarpeum
Os capitatum
Ligamenta basium [ossium metacarpalium] interossea
I
V
Ligamentum basium [ossium metacarpalium] volare
Ligamentum carpometacarpeum volare
IV
II
III
Ossa metacarpalia

289. Joints of the right hand, *articulatio manus,*

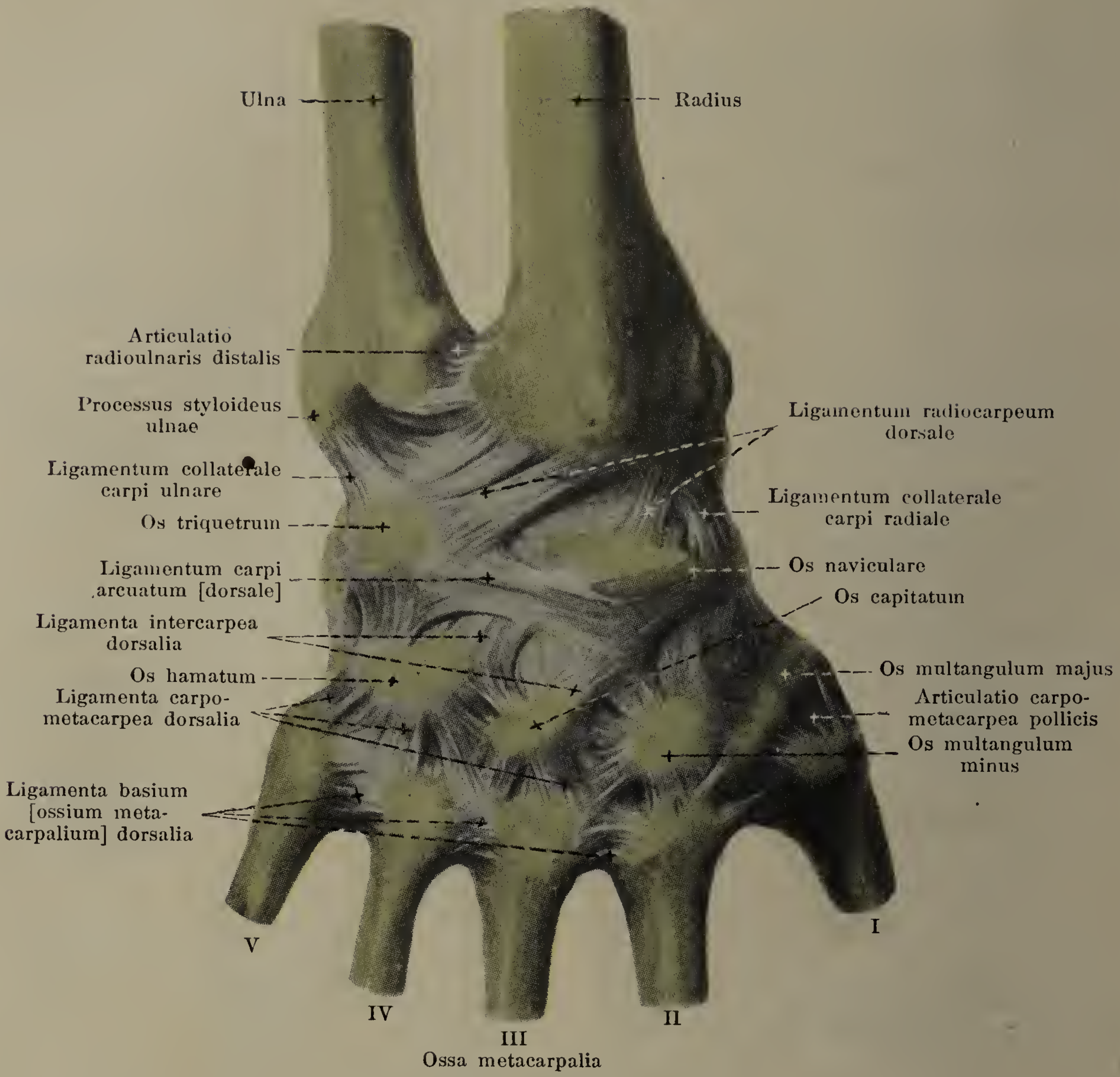
in supination of the hand, from the volar surface.

The hand can be moved towards the forearm bones; simultaneously with all such articulations there is also movement of the bones of the carpus. To the **articulatio manus** *(joint of the hand)* (see also Figs. 290 and 291) belong therefore *articulatio radiocarpea* and the *articulatio intercarpea.*

In the formation of the *articulatio radiocarpea (wrist-joint)* the proximal joint surfaces of the ossa naviculare, lunatum, triquetrum move upon the facies articularis carpea of the radius and upon the distal surface of the neighboring discus articularis. Its wide loose *capsula articularis* is attached to the circumference of the articular surfaces. It is strengthened by the powerful *ligamentum collaterale carpi radiale* (O. T. external lateral ligament) which extends from the processus styloideus radii to the os naviculare, and by the longer and weaker *ligamentum collaterale carpi ulnare* (O. T. internal lateral ligament) which extends from the processus styloideus ulnae to the os triquetrum. On the volar surface runs also the broad *ligamentum radiocarpeum volare* (O. T. anterior ligament) which arises from the processus styloideus and from the volar margin of the facies articularis carpea of the radius and goes in several bundles to the ossa naviculare, lunatum, triequetrum, capitatum.

The *articulatio intercarpea* connects and permits motion among the bones of the wrist; the individual bones are connected among one another by small *capsulae articulares.* On the volar surface there are several strengthening ligaments, short, flat, almost transversely directed, *ligamenta intercarpea volaria* (O. T. palmar ligaments); of these, those which radiate out from the os capitatum to the adjoining bones are grouped together as the *ligamentum carpi radiatum.*

In the formation of the *articulatio ossis pisiformis,* the dorsal surface of the os pisiforme glides upon the volar surface of the os triquetrum; a small, loose *capsula articularis* connects the borders of the surfaces. From the os pisiforme, the powerful *ligamentum pisohamatum* goes to the hamulus ossis hamati, the *ligamentum pisometacarpeum* to the basis ossis metacarpalis III—V both ligaments being really continuations of the tendon of the m. flexor carpi ulnaris.


Ulna
Radius
Articulatio radioulnaris distalis
Processus styloideus ulnae
Ligamentum collaterale carpi ulnare
Os triquetrum
Ligamentum carpi arcuatum [dorsale]
Ligamenta intercarpea dorsalia
Os hamatum
Ligamenta carpometacarpea dorsalia
Ligamenta basium [ossium metacarpalium] dorsalia
Ligamentum radiocarpeum dorsale
Ligamentum collaterale carpi radiale
Os naviculare
Os capitatum
Os multangulum majus
Articulatio carpometacarpea pollicis
Os multangulum minus
V
IV
III
II
I
Ossa metacarpalia

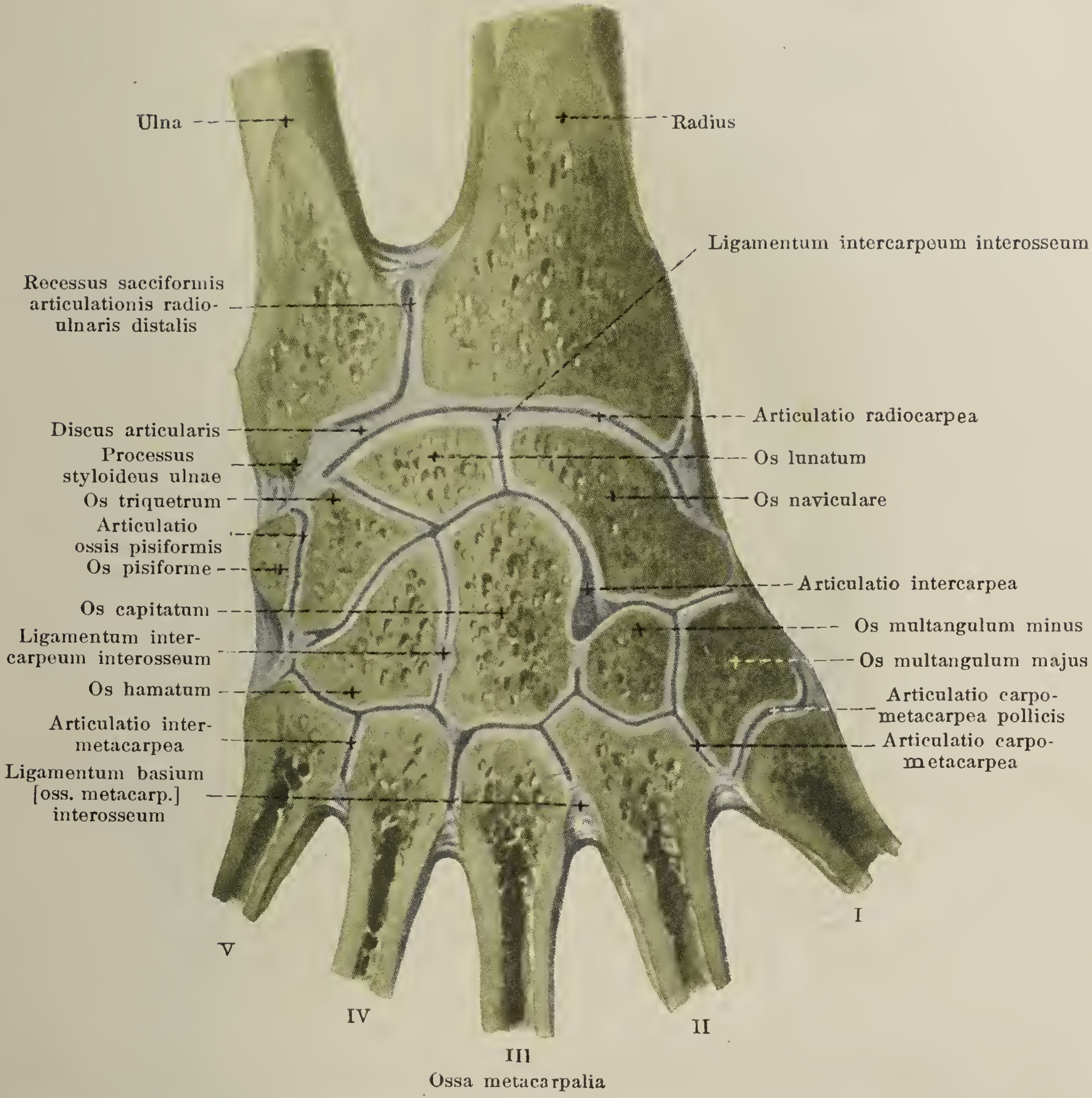
290. Joints of the right hand, ***articulatio manus,***
in supination of the hand, viewed from the back of the hand.

Articulatio manus (continued) (see also Figs. 289 and 291). On the dorsal surface, the capsule of the *articulatio radiocarpea* is strengthened by the *ligamentum radiocarpeum dorsale* (O. T. posterior ligament) which goes from the dorsal margin of the facies articularis carpea radii particularly to the os triquetrum and also to the ossa lunatum and naviculare; the band to the os naviculare is often not especially well developed and may be absent altogether.

The *articulatio intercarpea* possesses on the dorsal surface several short strengthening ligaments, *ligamenta intercarpea dorsalia* (O. T. dorsal ligaments), which run usually transversely. A powerful ligament, *ligamentum carpi arcuatum [dorsale]* is directed from the os naviculare straight to the os triquetrum, passing over the os lunatum on its way; it assists in forming the socket for the head of the os capitatum and for the os hamatum.

The *articulationes carpometacarpeae (carpometacarpal articulations)* are formed on the one side by the distal surfaces of the bones of the second row of the carpus, on the other side by the proximal surfaces of the ossa metacarpalia. Several short perpendicular and oblique ligaments on the volar and dorsal surfaces, *ligamenta carpometacarpea dorsalia et volaria* (O. T. dorsal and palmar ligaments) serve to their *capsulae articulares* as strengthening ligaments; the ligament which extends from the hamulus ossis hamati to the basis ossis metacarparlis V is called the *ligamentum hamatometacarpeum* (see Fig. 289).

The *articulationes intermetacarpeae (articulations of the metacarpal bones with one another)* have their origin in that the proximal ends of the second to the fifth metacarpal bone can move upon one another by means of their lateral surfaces which are covered with cartilage. Their *capsulae articulares* are strengthened by short transversely directed fibre bands, *ligamenta basium [ossium metacarpalium] dorsalia et volaria,* of which there are four on the back of the hand, but only three in the hollow of the hand (the ligament between the os metacarpale I and II is absent) (see also Fig. 289).


Ulna
Radius
Ligamentum intercarpeum interosseum
Recessus sacciformis articulationis radio-ulnaris distalis
Articulatio radiocarpea
Discus articularis
Os lunatum
Processus styloideus ulnae
Os triquetrum
Os naviculare
Articulatio ossis pisiformis
Os pisiforme
Articulatio intercarpea
Os capitatum
Os multangulum minus
Ligamentum intercarpeum interosseum
Os multangulum majus
Os hamatum
Articulatio carpometacarpea pollicis
Articulatio intermetacarpea
Articulatio carpometacarpea
Ligamentum basium [oss. metacarp.] interosseum
V
I
IV
II
III
Ossa metacarpalia

291. Joints of the right hand, ***articulatio manus,***
in supination of the hand, from the back of the hand.

(The surface of a frozen hand has been filed off until the joint slits have been opened.)

Articulatio manus (continued) (see also Figs. 289 and 290). The joint cavity of the *articulatio radiocarpea* is often connected with that of the articulatio radioulnaris distalis (see p. 204), seldom with that of the articulatio intercarpea.

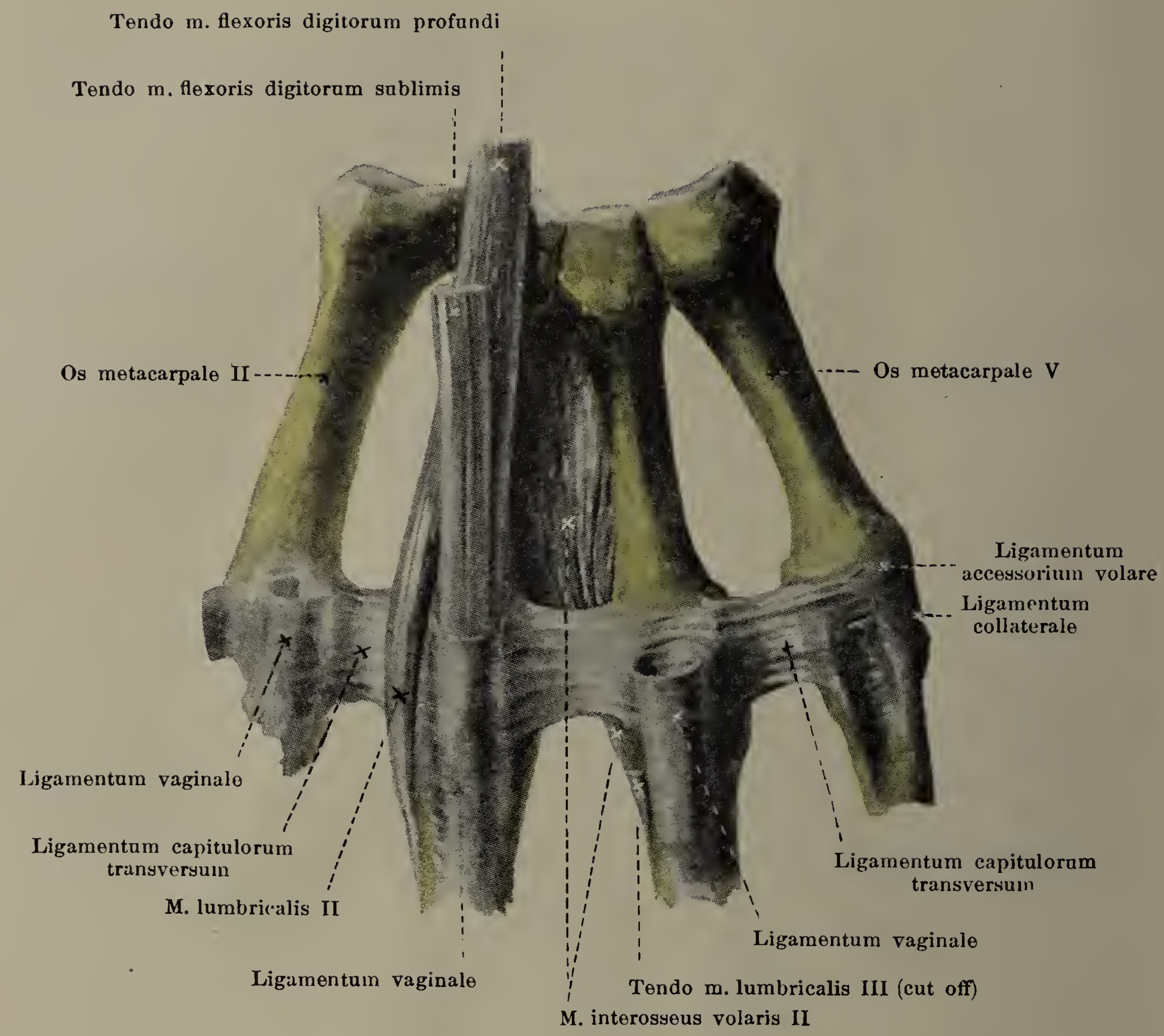
The slits between the individual joint surfaces of the bones which together form the *articulatio intercarpea* are usually all connected not only with one another, but also between the ossa multangula with the joint cavities of the articulationes carpometacarpeae of the second and third finger and intermetacarpeae of the second, third and fourth finger. Short, strong *ligamenta intercarpea interossea* extend in the depth in a transverse direction between the neighboring wrist bones of the same row.

The joint slit of the *articulatio ossis pisiformis* is in about a third of the cases connected with the articulatio radiocarpea.

In the *articulationes carpometacarpeae* of the second and third finger the joint slits are usually connected with those of the articulatio intercarpea, and with those of the *articulationes intermetacarpeae* between the second, third and fourth finger; the *articulationes carpometacarpeae* and the *articulatio intermetacarpea* of the fourth and fifth finger are usually separated from the others, the *articulatio carpometacarpea pollicis* is separated always.

The three *articulationes intermetacarpeae* possess, in the depth, short, transverse *ligamenta basium [ossium metacarpalium] interossea.*

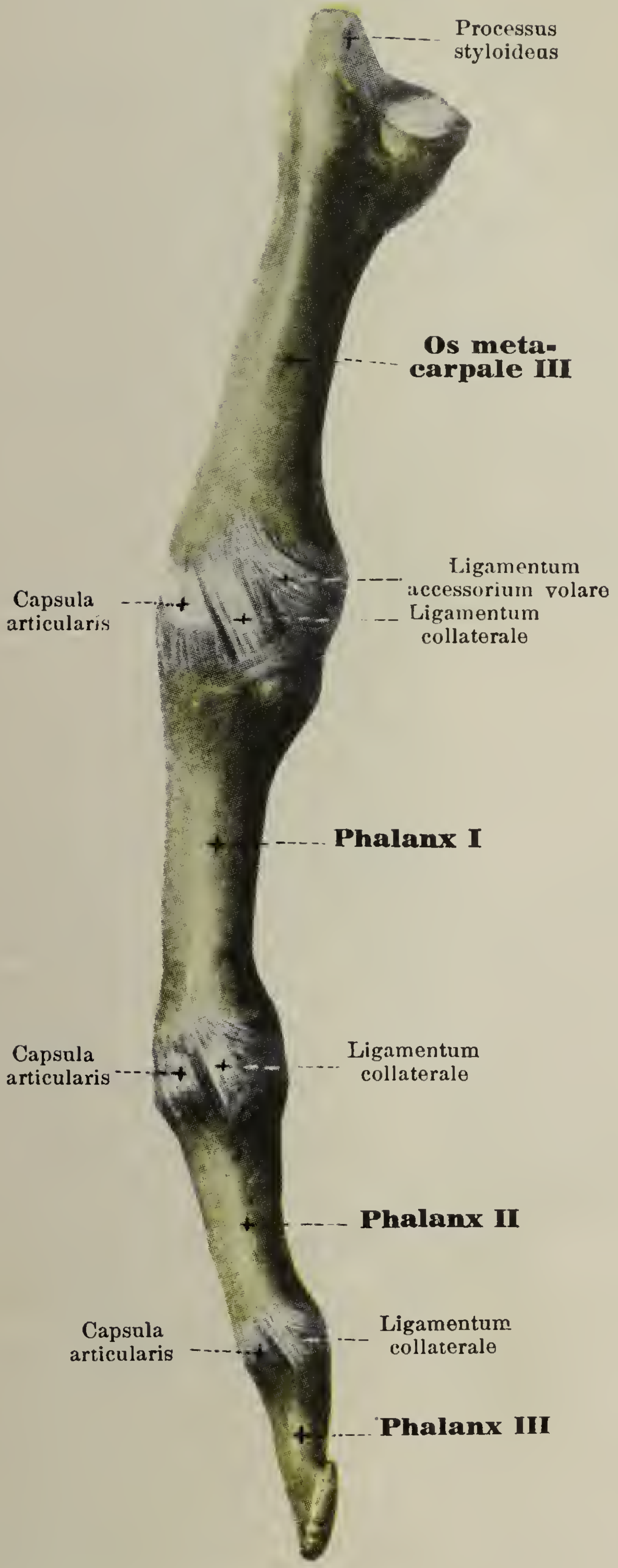
The joint capsules go off from the margins of the surfaces covered with cartilage.


Tendo m. flexoris digitorum profundi
Tendo m. flexoris digitorum sublimis
Os metacarpale II
Os metacarpale V
Ligamentum accessorium volare
Ligamentum collaterale
Ligamentum vaginale
Ligamentum capitulorum transversum
M. lumbricalis II
Ligamentum vaginale
Ligamentum capitulorum transversum
Ligamentum vaginale
Tendo m. lumbricalis III (cut off)
M. interosseus volaris II

292. Metacarpal bones and first phalanges of the second to the fifth finger of the right hand with ligaments, from the volar surface.

The articulated connections between the metacarpal bones and the fingers are called the **articulationes metacarpophalangeae** (see also Fig. 293). They are formed in such a manner that the base of each phalanx I moves upon the capitulum of the os metacarpale. A tolerably loose *capsula articularis* connects the margins of the surfaces covered with cartilage.

Between the heads of the second to the fifth os metacarpale a flat powerful *ligamentum capitulorum [ossium metacarpalium] transversum* (O. T. transverse metacarpal ligament) stretches out transversely over the distal end of the corresponding spatium interosseum metacarpi on the volar surface. It is partially fastened to the lateral surfaces of the capitulum; in part it goes over into the volar portion of the joint capsule and there connects with the ligamentum accessorium volare and with a small plate of fibrocartilage, which strengthens the joint capsule on the volar side and is connected with the base of the phalanx; in part it helps to form the ligamenta vaginalia for the flexor tendons of the fingers. The ligament separates the distal portions of the mm. interossei from those of the mm. lumbricales in that the former run on the dorsal surface the, latter on the volar surface of it.



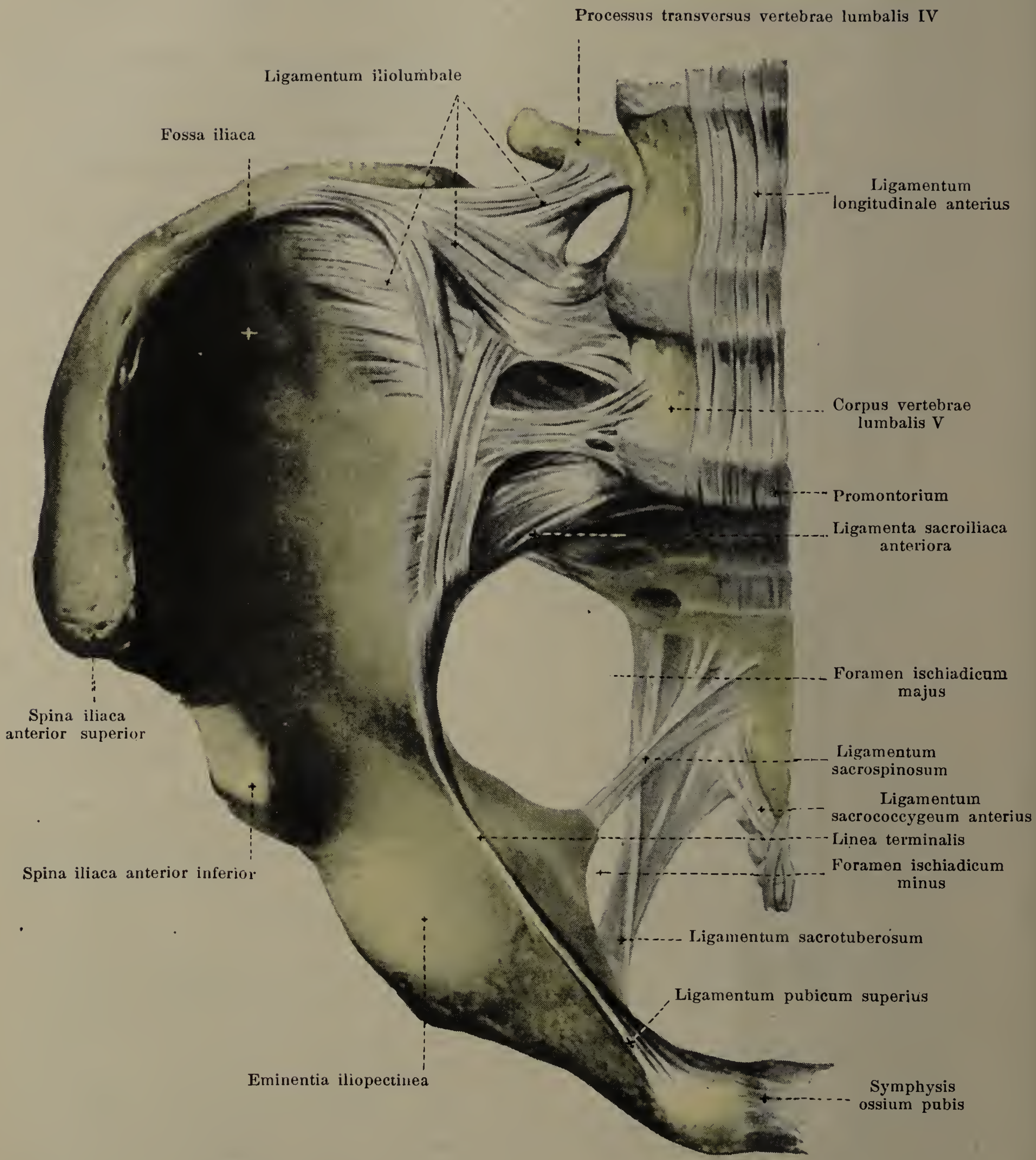
293.

Metacarpal bone and phalanges of the third finger of the right hand with ligaments,

from the radial side.

The **articulationes metacarpophalangeae** (continued) (see also Fig. 292) possess a *ligamentum collaterale* (O. T. lateral ligament) as a strengthening ligament, one on the radial and one on the ulnar side which extends from the lateral surface of the capitulum ossis metacarpalis obliquely distalward and volarward to the base of the first phalanx. In addition, a *ligamentum accessorium volare* (O. T. transverse metacarpal ligament) with one limb on each side, radial and ulnar, from the capitulum ossis metacarpalis just volarward from the ligamentum collaterale runs arch-like to the volar surface of the joint and attaches there to the border of the fibrocartilaginous disc (see page 208); on the volar surface it is united with the ligamentum capitulorum transversum (see Fig. 292).

Articulationes digitorum manus *(finger joints)* is the name of the movable connections between the phalanges of the fingers. They arise from the fact that the base of each phalanx II is movably connected with the trochlea of each phalanx I and in the same way the base of each phalanx III with the trochlea of each phalanx II. In the first finger (thumb), only one such joint is present; in the second to the fifth finger always two. Loose *capsulae articulares* connect the margins of the cartilaginous joint-surfaces with one another and are strengthened by powerful *ligamenta collateralia* (O. T. lateral ligaments) which run to the radial and ulnar side in a manner entirely analogous to that in the articulationes metacarpophalangeae. Furthermoore there are on the volar side of the joints as well as on the metacarpophalangeal joints, small discs of fibrocartilage, inwoven in the joint capsule.


Processus transversus vertebrae lumbalis IV
Ligamentum iliolumbale
Fossa iliaca
Ligamentum longitudinale anterius
Corpus vertebrae lumbalis V
Promontorium
Ligamenta sacroiliaca anteriora
Foramen ischiadicum majus
Spina iliaca anterior superior
Ligamentum sacrospinosum
Ligamentum sacrococcygeum anterius
Linea terminalis
Spina iliaca anterior inferior
Foramen ischiadicum minus
Ligamentum sacrotuberosum
Ligamentum pubicum superius
Eminentia iliopectinea
Symphysis ossium pubis

294. Ligaments of the right half of the pelvis,

from in front and somewhat from above.

The **pelvis bones** are connected by means of two joints: — the paired *articulatio sacroiliaca* and the unpaired *symphysis ossium pubis.*

In the **articulatio sacroiliaca** (see also Figs. 295 and 296) the facies auricularis ossis sacri and the facies auricularis ossis ilium of each side are in contact. A short, tight *capsula articularis* connects the margins of the cartilaginous surfaces; it is strengthened on the anterior surface by the *ligamenta sacroiliaca anteriora,* which, considered as a whole, run as broad thin fibre plate from the lateral portion of the basis and facies pelvina of the sacrum transversely to the medial surface of the ilium and are there attached in the periphery of the linea arcuata, eventually also in the sulcus paraglenoidalis.

The *ligamentum iliolumbale* (O. T. iliolumbar ligament) (see also Fig. 295), must also be regarded as a strengthening ligament (in the wider sense) for this joint. This forms a powerful flat fibre band which has its origin from the processus transversus of the fourth and especially the fifth lumbar vertebra; one part of the fibres extends from there to the posterior portion of the crista iliaca, another larger part broadens out on the inner surface of the ala ossis ilium and on the upper surface of the pars lateralis ossis sacri.

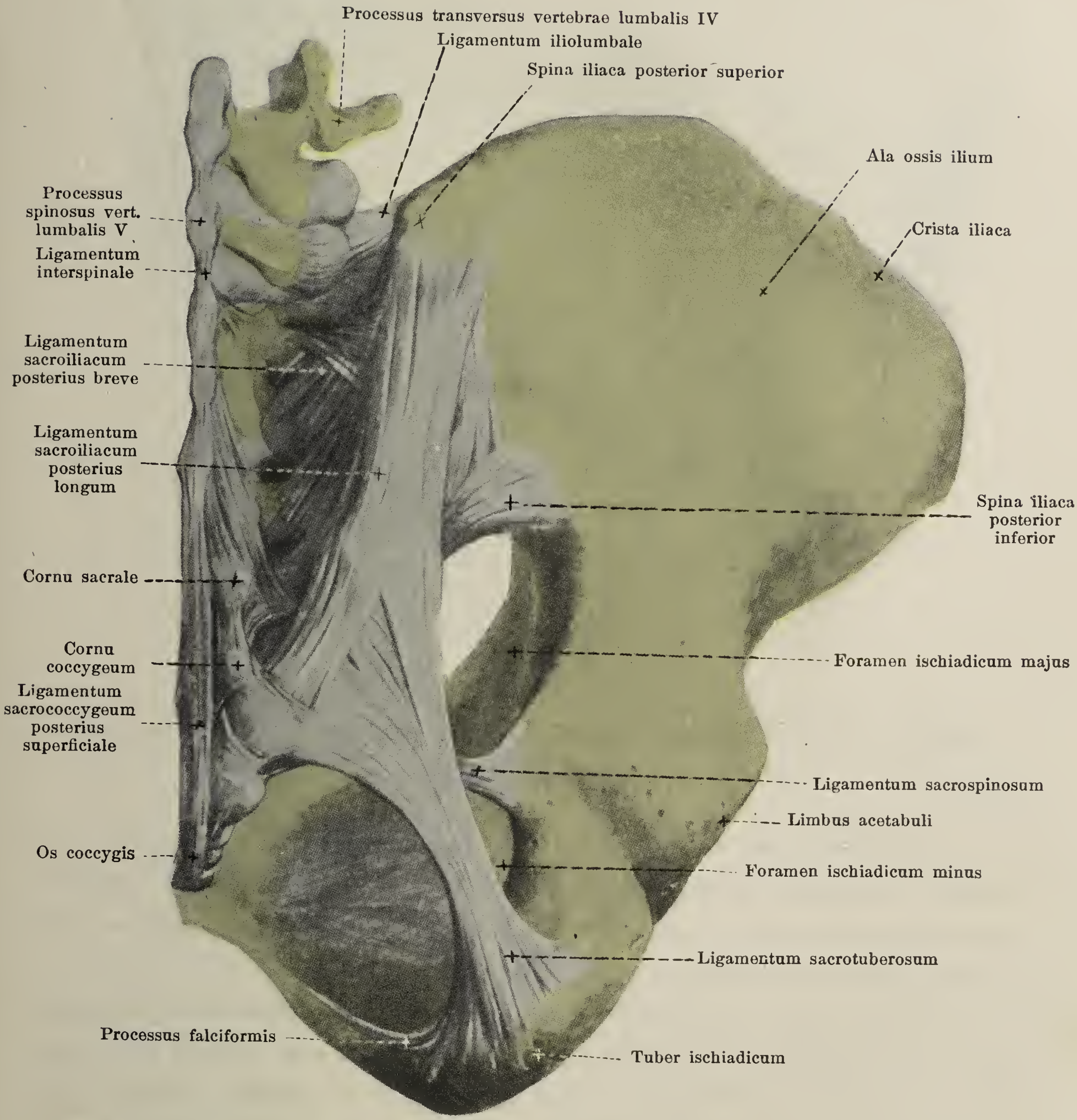
Articulatio sacroiliaca (continued) (see also Figs. 294 and 296). It is strengthened on the posterior surface by the *ligamenta sacroiliaca interossea* (see p. 214) and the *ligamenta sacroiliaca posteriora breve et longum.* The latter form the broad mass of fibre bands, only indistinctly separated from one another, which ascend obliquely from the region of the crista sacralis articularis and crista sacralis lateralis of the sacrum toward the ala ossis ilium where they are attached to the spinae iliacae posteriores and between them, the main mass of them, especially the superficial bands, passing to the spina iliaca posterior superior; of these the fibrous bands which come from the region of the first, second and third sacral vertebra are called the *ligamentum sacroiliacum posterius breve*, those from the region of the fourth sacral vertebra, the *ligamentum sacroiliacum posterius longum.* These ligaments cover over the ligamenta sacroiliaca interossea completely from behind, are fused with them and lie close upon them.

Of great importance for the form and firmness of the pelvis are also the **ligamentum sacrotuberosum** and the **ligamentum sacrospinosum** (see also Fig. 294).

The *ligamentum sacrotuberosum* (O. T. posterior or great sacrosciatic ligament) arises broad and thin from the spinae iliacae posteriores superior et inferior as well as from the lateral margin of the sacrum and of the two upper coccygeal vertebrae; it is accordingly intimately connected in its upper part with the ligamenta sacroiliaca posteriora. The fibres converge to form a strong flat ligament which extends obliquely forward, downward and lateralward and becomes attached to the medial edge of the tuber ischiadicum where it again broadens out; a narrow band which extends as a continuation of some fibre bundles from this point along the medial margin of the ramus inferior ossis ischii, is called the *processus falciformis* (O. T. falciform ligament).

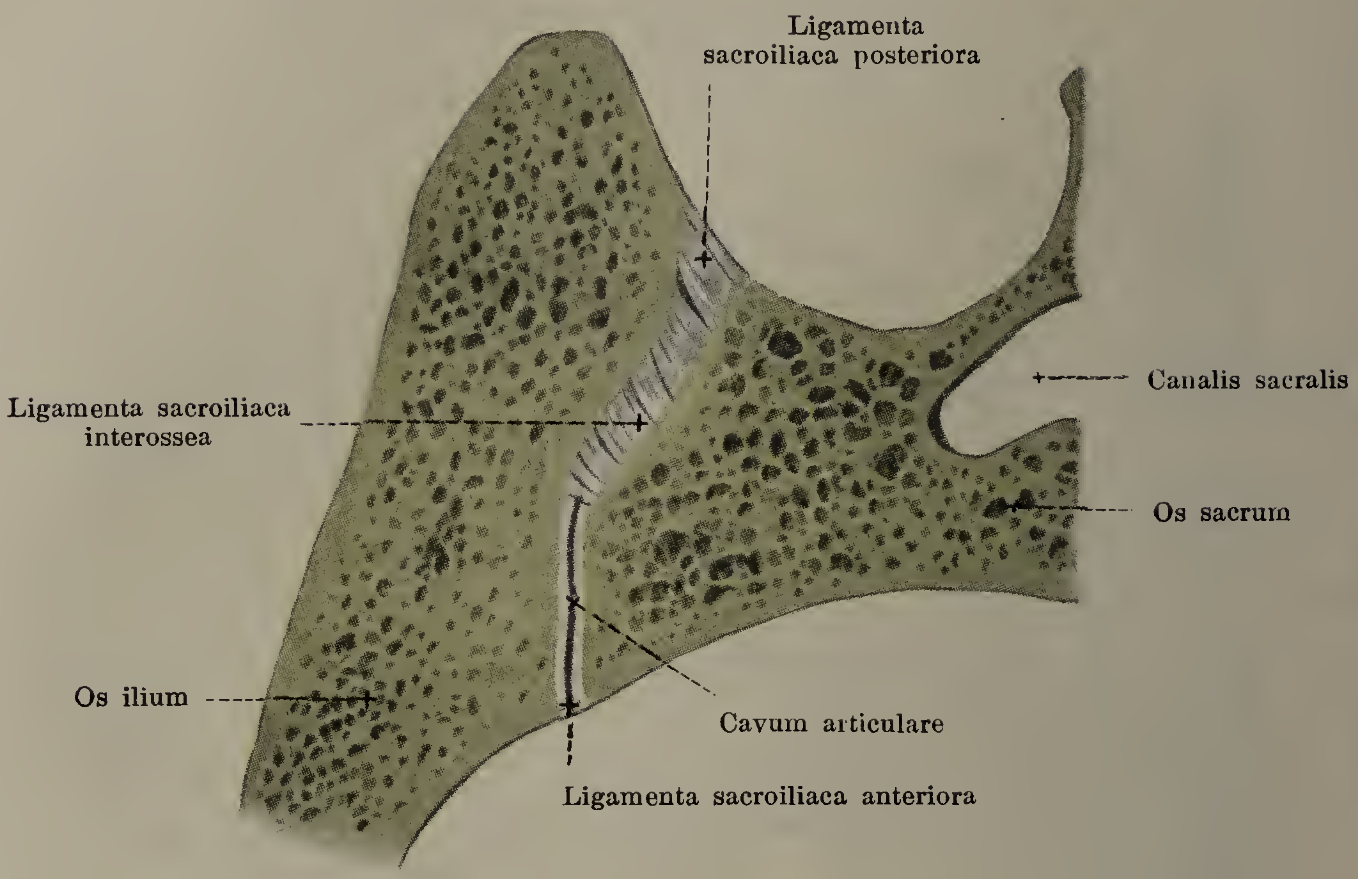
The *ligamentum sacrospinosum* (O. T. anterior or lesser sacrosciatic ligament) is essentially thinner than the preceeding; it arises on the lateral margin of the lower portion of the sacrum and of the upper coccygeal vertebrae, extends past the anterior surface of the ligamentum sacrotuberosum forward and lateralward, narrowing as it goes, and is attached to the spina ischiadica; at the point where it crosses the ligamentum sacrotuberosum, it fuses with it. The ligamentum sacrospinosum forms, with the m. coccygeus (see p. 346), on whose dorsal side it lies, a common mass of variable composition; mostly the muscle bundles predominate and project beyond the ligament both above and below.

The ligamentum sacrotuberosum, as well as the ligamentum sacrospinosum, stretches out medianward from the two incisurae ischiadicae respectively between them so that these notches are transformed into foramina which are surrounded partly by bone, partly by ligaments: the incisura ischiadica major becomes the rounded-quadrangular *foramen ischiadicum majus* (O. T. great sacrosciatic foramen), the incisura ischiadica minor the triangular *foramen ischiadicum minus* (O. T. lesser sacrosciatic foramen) (see also Fig. 294). The foramen ischiadicum majus is filled up in completely by the m. piriformis (see p. 347); the part above the muscle is called *foramen suprapiriforme,* that below the muscle *foramen infrapiriforme.*


Processus transversus vertebrae lumbalis IV
Ligamentum iliolumbale
Spina iliaca posterior superior
Ala ossis ilium
Crista iliaca
Processus spinosus vert. lumbalis V
Ligamentum interspinale
Ligamentum sacroiliacum posterius breve
Ligamentum sacroiliacum posterius longum
Spina iliaca posterior inferior
Cornu sacrale
Cornu coccygeum
Foramen ischiadicum majus
Ligamentum sacrococcygeum posterius superficiale
Ligamentum sacrospinosum
Limbus acetabuli
Os coccygis
Foramen ischiadicum minus
Ligamentum sacrotuberosum
Processus falciformis
Tuber ischiadicum

295. Ligaments of the right half of the pelvis,

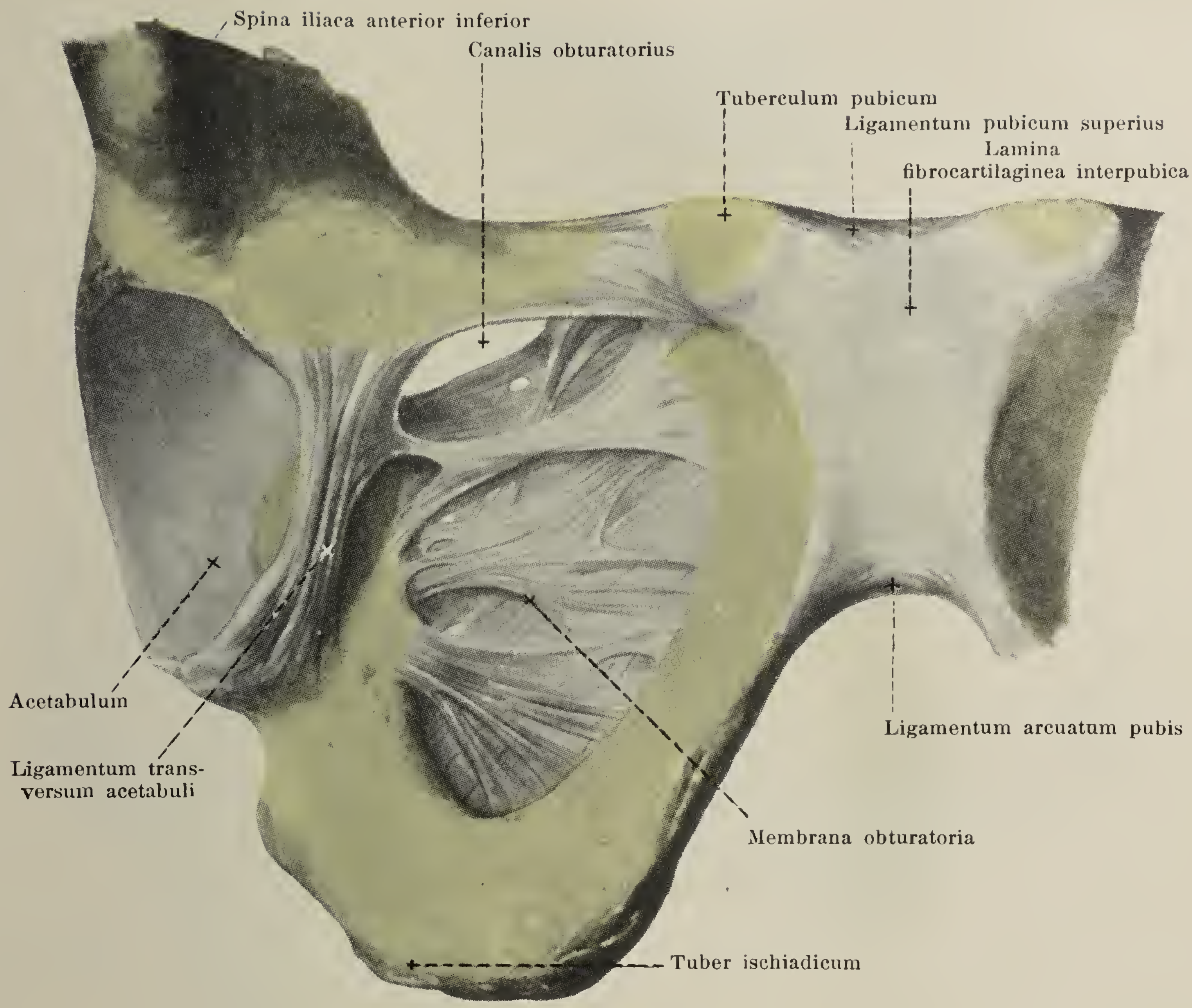
form behind.


Ligamenta sacroiliaca posteriora
Canalis sacralis
Ligamenta sacroiliaca interossea
Os sacrum
Os ilium
Cavum articulare
Ligamenta sacroiliaca anteriora

296. Articulatio sacroiliaca dextra, frontal section.
Posterior half of section, from in front.

Articulatio sacroiliaca (continued) (see also Figs. 294 and 295). It possesses an unevenly curved joint slit; the adjoining articular surfaces are completely covered by cartilage, and are smooth, but they present several irregular projections which fit into corresponding depressions of the other bone.

On the dorsal surface there are present, as strengthening ligaments, the *ligamenta sacroiliaca interossea.* Under this name are included the mass of short fibre bands which are covered over completely behind by the ligamenta sacroiliaca posteriora (not separable from them) and which extend obliquely upward and backward from the tuberositas sacralis [ossis sacri] to the tuberositas iliaca [ossis ilium], eventually, also to the sulcus paraglenoidalis; they fill completely they irregular depression which is situated behind the joint cavity between these two rough surfaces, and are not visible in the uninjured joint.

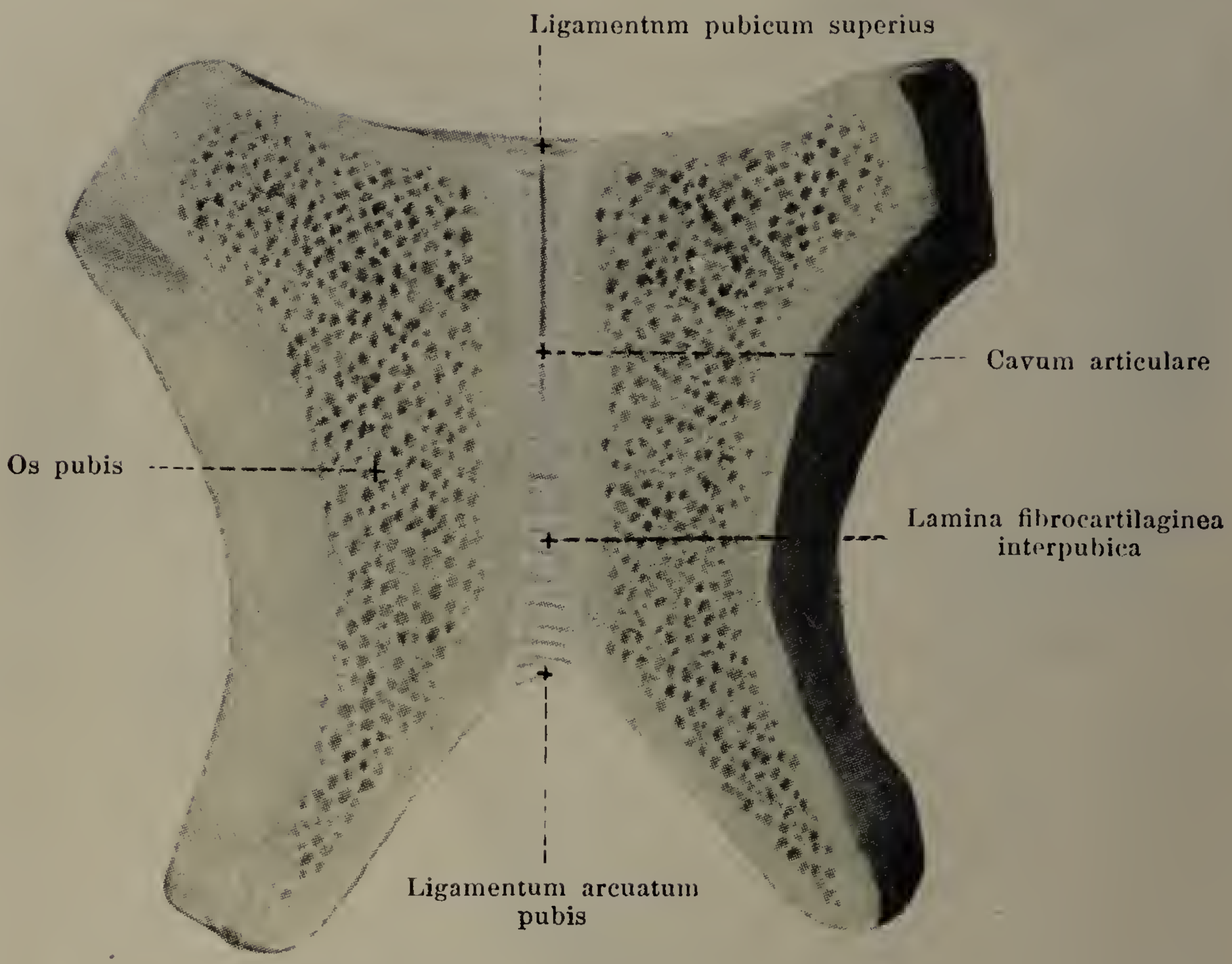

Spina iliaca anterior inferior
Canalis obturatorius
Tuberculum pubicum
Ligamentum pubicum superius
Lamina fibrocartilaginea interpubica
Acetabulum
Ligamentum transversum acetabuli
Ligamentum arcuatum pubis
Membrana obturatoria
Tuber ischiadicum

297. Symphysis pubis and right half of pelvis with ligaments, from in front and below.

(Only those fibres of the labrum glenoidale which form the ligamentum transversum acetabuli have been retained.)

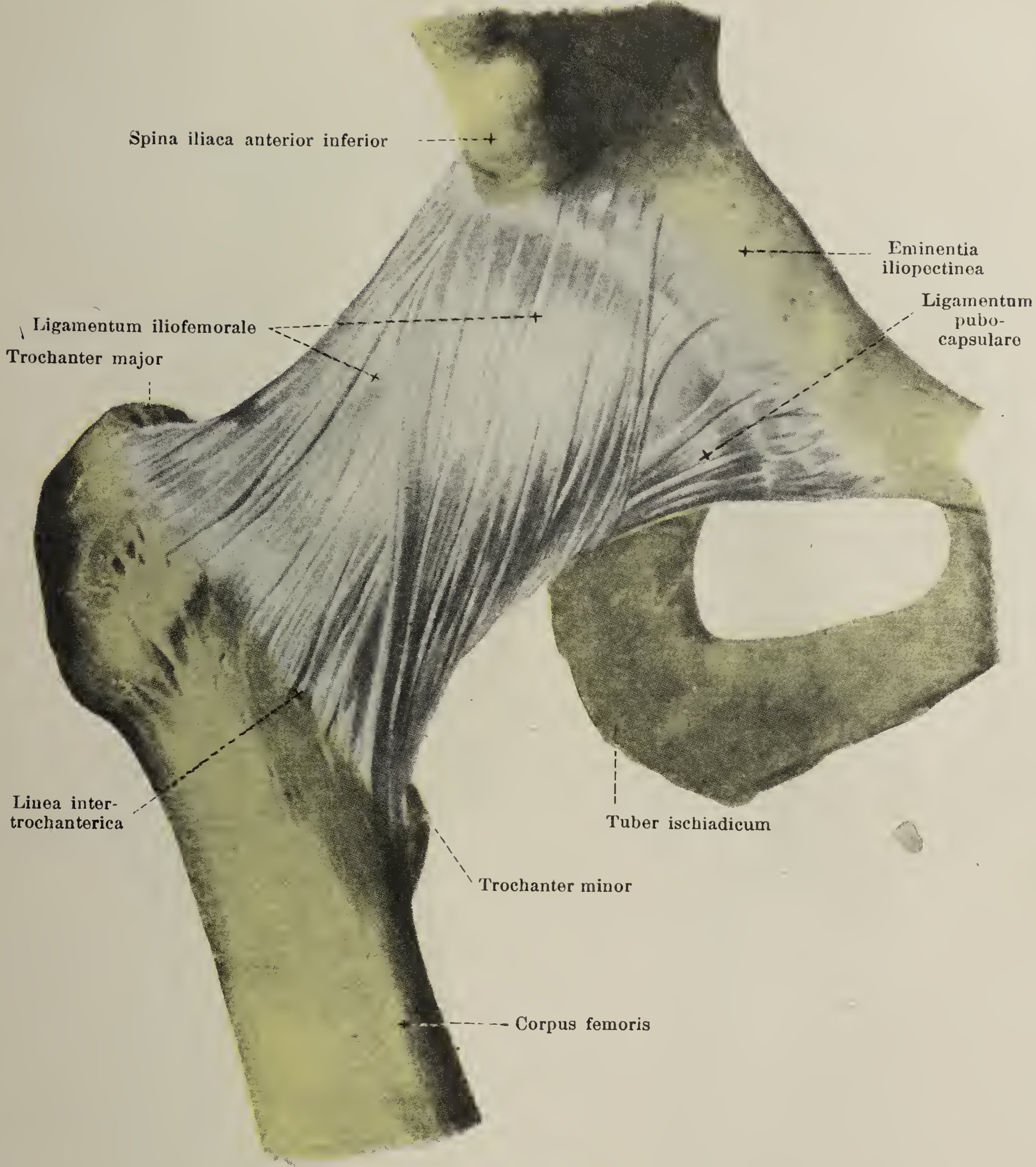
The **membrana obturatoria** is usually a thin fibre plate which almost completely closes the foramen obturatum. The fibres arise from the margins of the foramen, coming in the lower and posterior part from the posterior surface of the same. The direction of the fibres is usually transverse. The uppermost bands stretch out below the sulcus obturatorius between the tubercula obturatoria and transform this groove into the short *canalis obturatorius* (for the a. and vv. obturatoriae; n. obturatorius). Variably developed bands of fibres, which lie upon the membrane externally, are connected with the capsule of the hip joint and with the ligamentum transversum acetabuli.

In the unpaired **symphysis ossium pubis** (see also Fig. 298) the two pubic bones are united with one another in the median plane. Between the opposing rough facies symphyseos, which are covered over with a layer of hyaline cartilage (thicker in the youth), is intercalated a fibrocartilaginous disc *(lamina fibrocartilaginea interpubica)* (O. T. interpubic disc). This projects somewhat on the posterior surface as a narrow ridge; in front it broadens essentially and is covered by a layer of decussating fibres which are connected with the tendons of the mm. recti abdominis. The uppermost, transverse fibre layer stretches out between the upper margins of the rami superiores of the pubic bones or rather between the tubercula pubica, and is called the *ligamentum pubicum superius;* lateralward it is continued on that side behind the tuberculum pubicum as a ridge upon the pecten ossis pubis (see Fig. 294) and there gives origin to a part of the m. pectineus. The sharp-angled triangular fibrous band which on the lower margin of the symphysis extends from the ramus inferior of one pubic bone to that of the other and which, above, is fused with the fibrocartilaginous disc, is called the *ligamentum arcuatum pubis* (O. T. subpubic ligament).


Ligamentum pubicum superius
Cavum articulare
Os pubis
Lamina fibrocartilaginea interpubica
Ligamentum arcuatum pubis

298. Symphysis pubis, opened by a frontal section. Posterior half, viewed from in front.

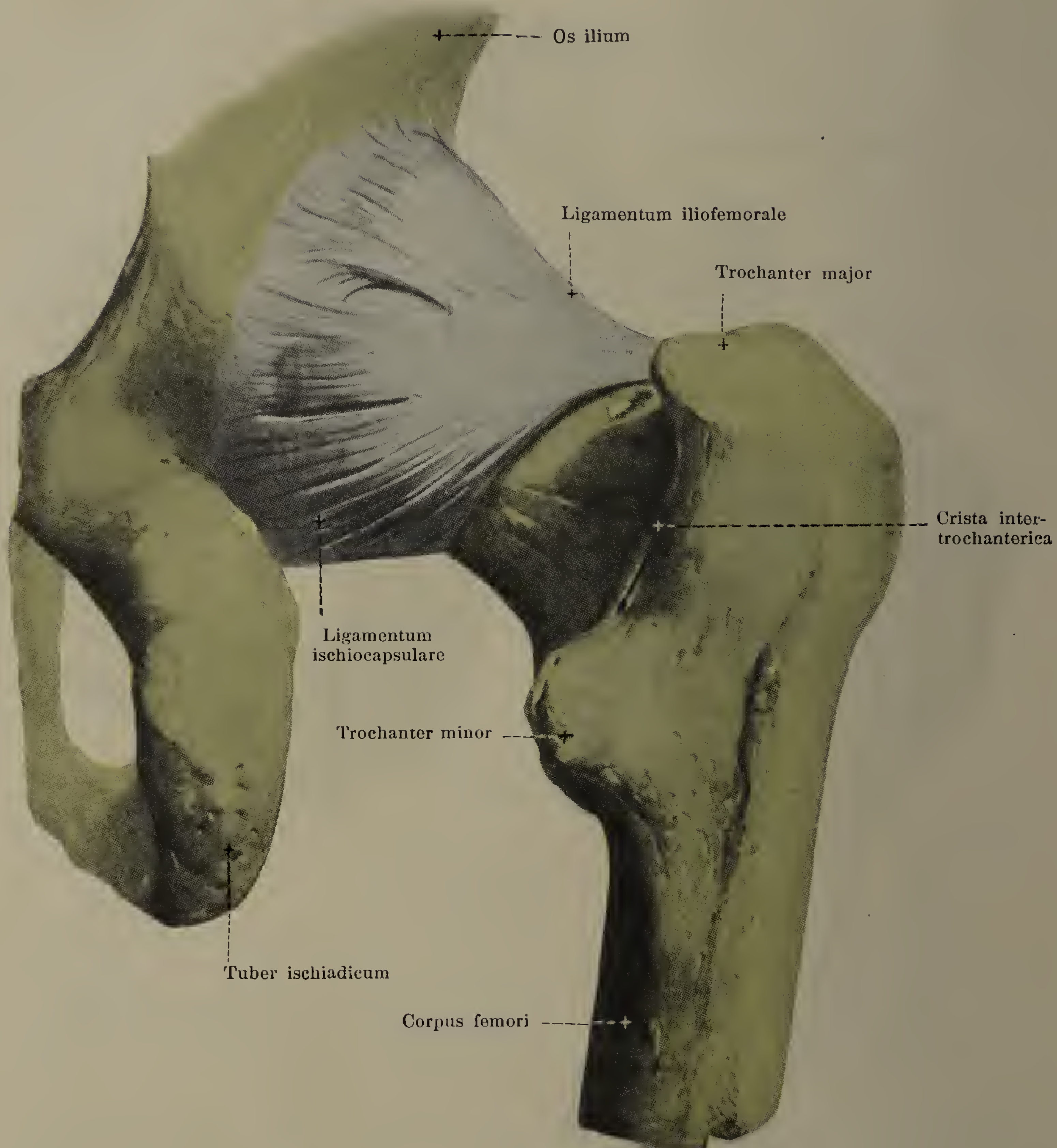
Symphysis ossium pubis (continued) (see also Fig. 297). It contains nearly constantly within its *lamina fibrocartilaginea interpubica* a small medianly situated joint slit, *cavum articulare,* which lies nearer the posterior margin than the anterior and extends almost over the upper half of the fibrocartilaginous mass: the joint slit is larger in the female than in the male. The strands of fibrocartilage run in the depth, mostly transversely, between the two layers of hyaline cartilage and are seen on median section to consist of concentrically arranged circular layers. Cartilage and fibrocartilage are very firmly united with one another.



299. Right hip joint, ***articulatio coxae,*** from in front.

The thigh bone moves against the pelvis in the **articulatio coxae** ***(hip joint)*** (see also Figs. 300—303), which arises from the fact that the caput femoris moves upon the facies lunata of the acetabulum. The latter is enlarged by means of a high three-cornered connective tissue ring, ***labrum glenoidale*** (O. T. cotyloid ligament) (see Figs. 301 and 303), which sits upon the limbus of the acetabulum and bridges over the incisura as the ***ligamentum transversum acetabuli;*** this has also a broad attachment to the margins of the incisura acetabuli and is connected with the fibres of the membrana obturatoria (see Fig. 297).

The *capsula articularis* (see Fig. 303) is strengthened on the anterior surface by the strong triangular *ligamentum iliofemorale.* It arises below and near the spina iliaca anterior inferior, broadens gradually and is fastened to the linea intertrochanterica in its whole length. Particularly powerful fibre bands run to the upper extremity of the linea intertrochanterica (region of the trochanter major), and somewhat weaker ones to the lower extremity of the same. The *ligamentum pubocapsulare* (O. T. pubofemoral ligament) lies on the medial, inferior side of the joint, comes from the corpus and ramus superior ossis pubis and runs partly to the upper margin of the trochanter minor, partly to the capsule in the same region and to the zona orbicularis.

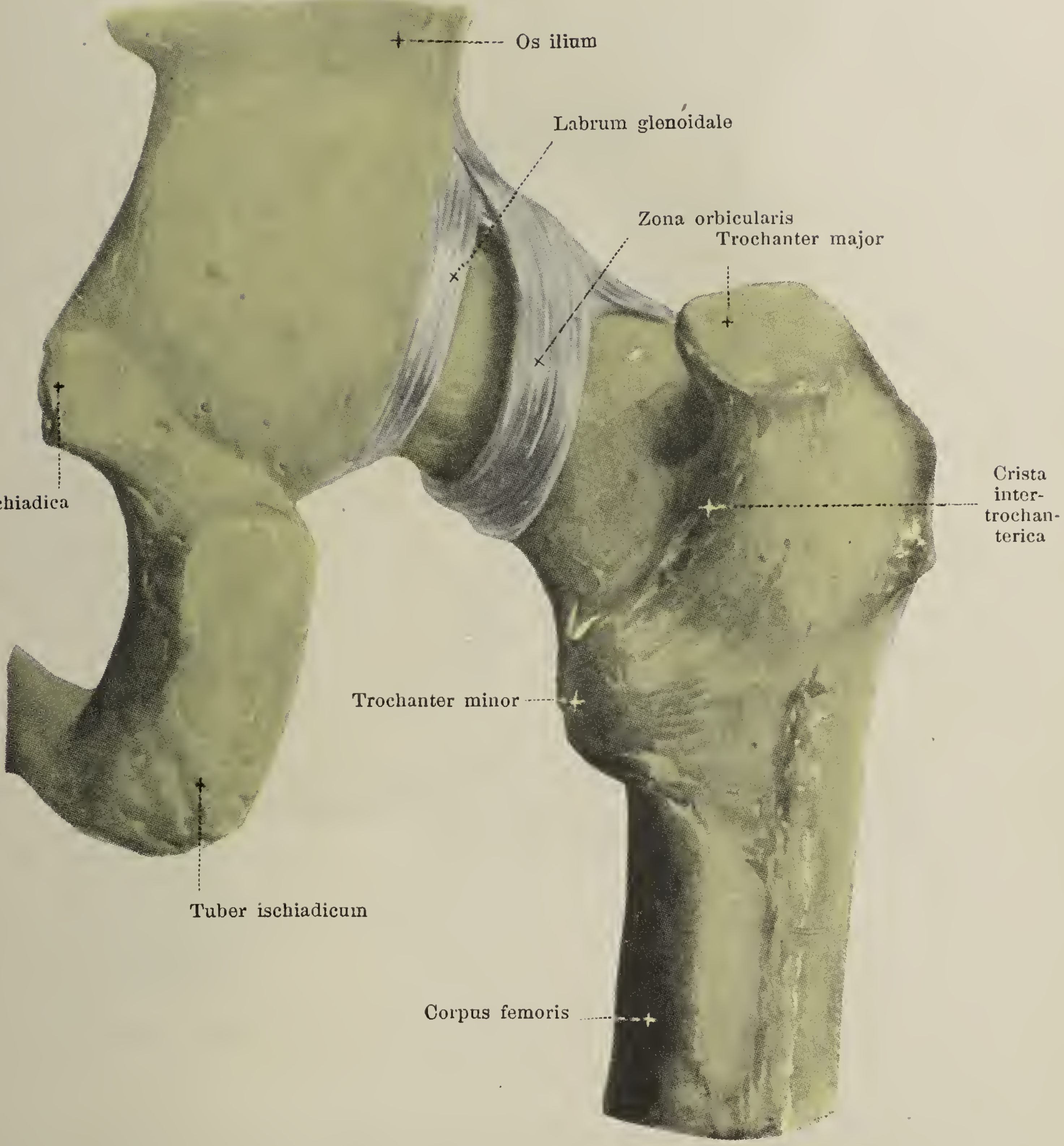


300. Right hip joint, ***articulatio coxae,*** from behind.

(The joint capsule, except for the strengthening ligaments, has been removed.)

Articulatio coxae (continued) (see also Figs. 299 and 301—303). It possesses, as a strengthening ligament of the posterior wall of the capsule, the ***ligamentum ischiocapsulare.*** This broad, thick ligament arises externally along the margin of the acetabulum in the whole extent of the corpus ossis ischii. Its fibres converge somewhat, run obliquely upward and lateralward and become attached for the most part to the anterior margin of the trochanter major at the upper extremity of the linea intertrochanterica; partly they are fastened to the zona orbicularis.

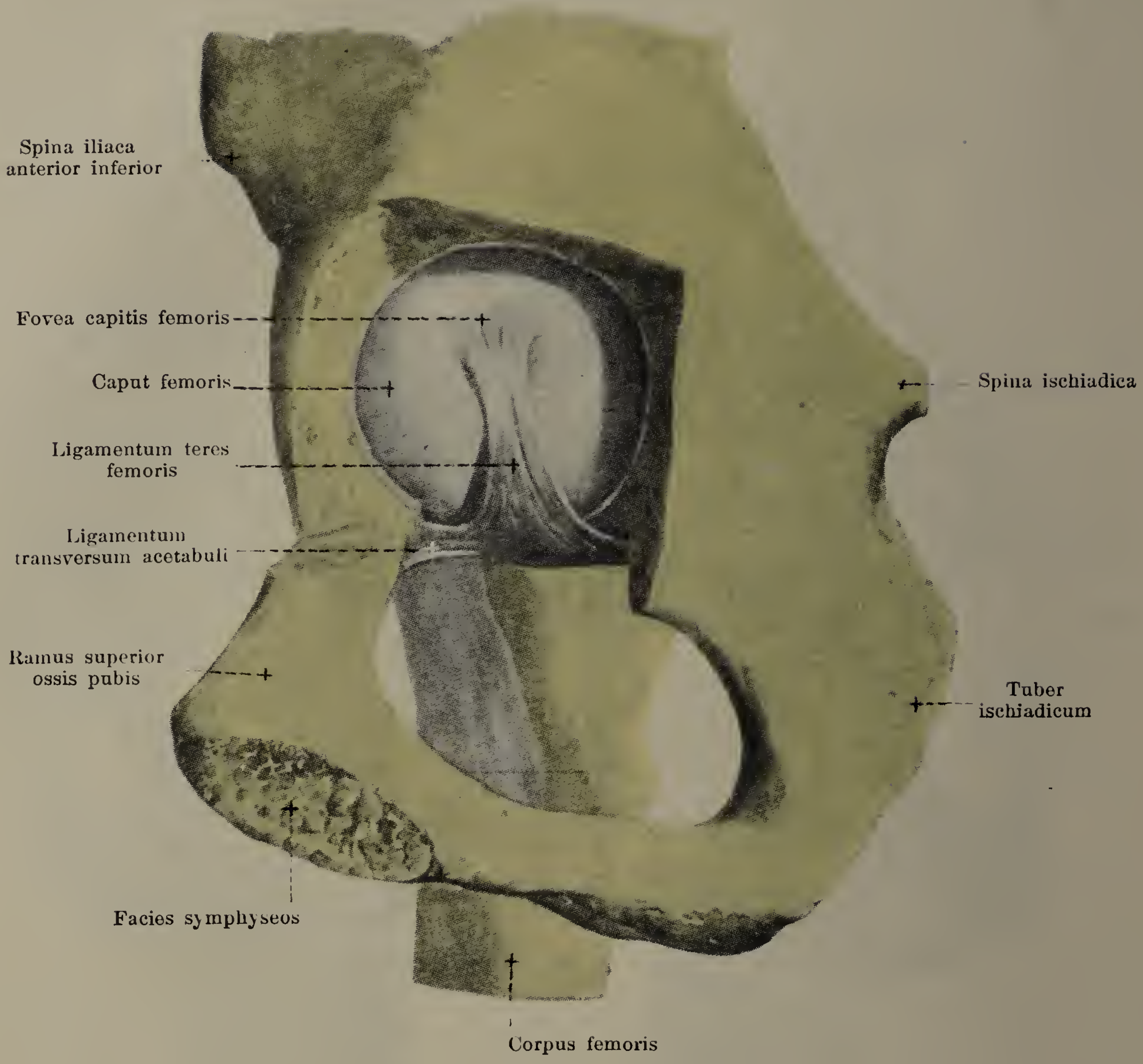
Between the ligamenta iliofemorale, pubocapsulare and ischiocapsulare the capsule is essentially thinner in three places; these places correspond to the points where the bones forming the acetabulum fuse with one another. The triangular field between the ligamentum iliofemorale and the ligamentum pubocapsulare is exceptionally thin; before it lies the bursa iliopectinea (see p. 350), which is sometimes united with the joint cavity by an opening that varies in size. Just as thin or still thinner is the region between the ligamenta pubocapsulare and ischiocapsulare.



301. Right hip joint, *articulatio coxae,*
from behind.

(The superficial layer of the capsule and the ligamentum ischiocapsulare have been removed.)

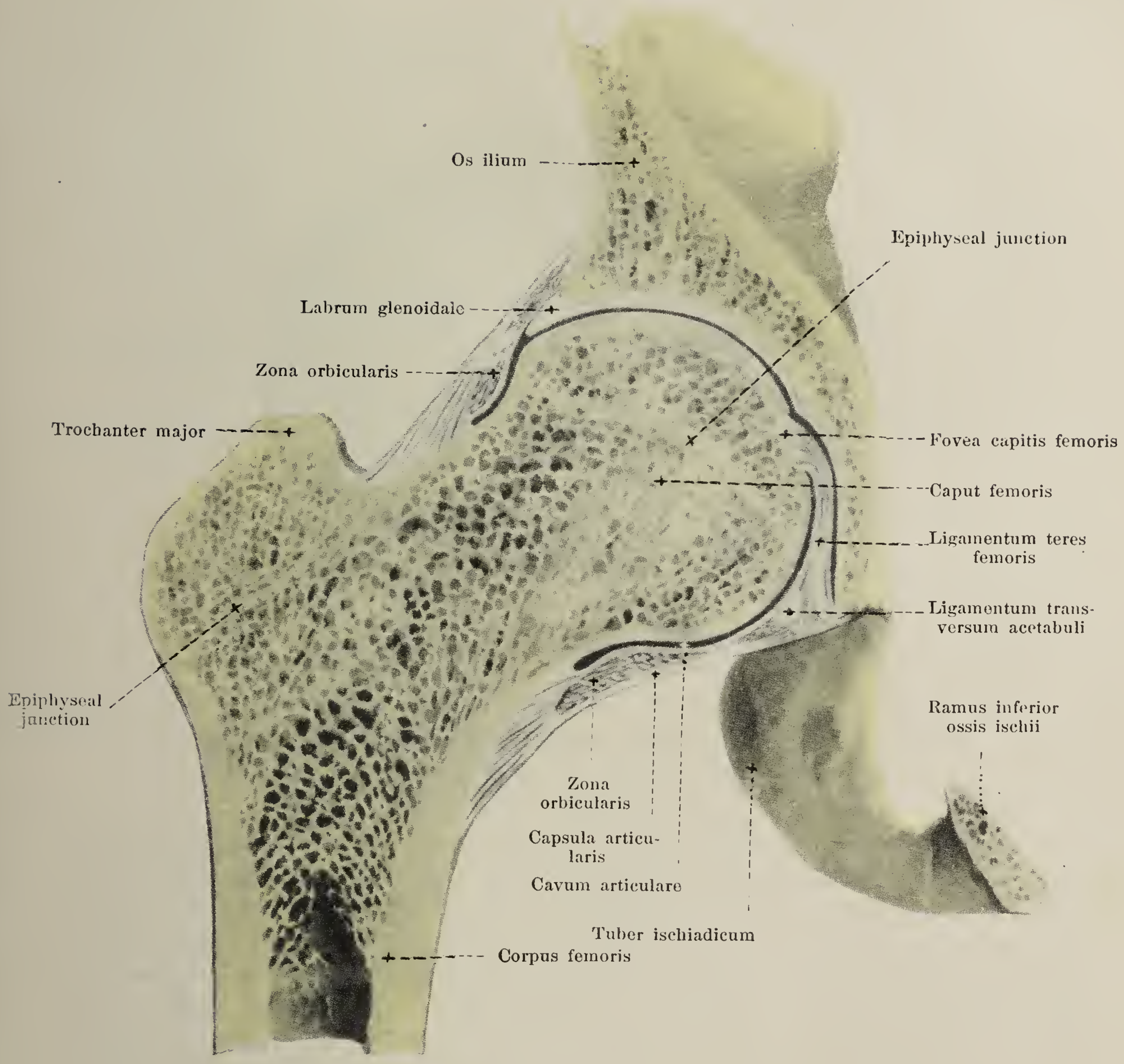
Articulatio coxae (continued) (see also Figs. 299, 300, 302 and 303). Its capsule is strengthened in the depth by the *zona orbicularis* (see also Fig. 303). This band of fibres, covered over completely by the other ligaments, but connected intimately with them, is strongest and most distinct above, behind and below; it surrounds the neck of the femur like a ring and is connected above with the bone below the spina iliaca anterior inferior. It extends therefore, essentially like a loop, from this point, downward behind the neck, then below the same and thence, before the same, back again, upward to its starting point; its lateral margin is formed of fibres which run purely circularly.



302. Right hip joint, *articulatio coxae,*
from the medial side.

(The bottom of the acetabulum has been chiselled away sufficiently to make the head of the femur visible.)

Articulatio coxae (continued) (see also Figs. 299—301 and 303). Hidden inside it is the *ligamentum teres femoris* (see also Fig. 303). This flatly rounded ligament arises by a broad origin in the neighborhood of the incisura acetabuli and from the ligamentum transversum acetabuli, becomes narrow above and is attached in the fovea capitis femoris. It lies in the fossa acetabuli between its floor and the medial inferior surface of the head of the femur so that the posterior margin of the ligament, when the body is upright, is approximately vertical in direction. The ligamentum teres is covered over by the stratum synoviale of the capsula articularis. Very rarely it may be very thin or may be absent altogether.

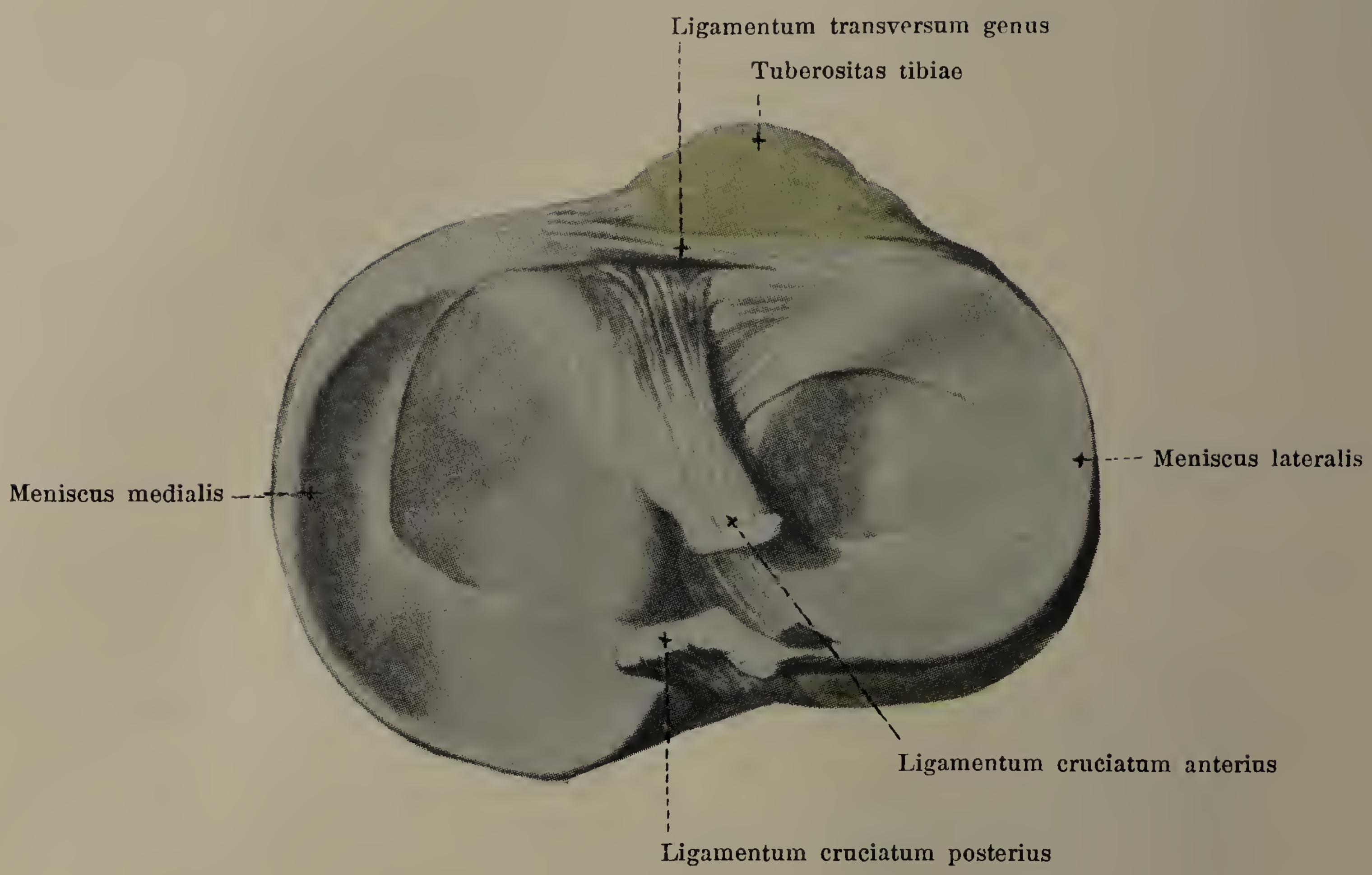


303. Right hip joint, *articulatio coxae.*

Frontal section through the same. Posterior half of section, viewed from in front.

(The joint surfaces have been somewhat pulled apart.)

Articulatio coxae (continued) (see also Figs. 299—302). Its *capsula articularis* arises at the margin of the acetabulum, chiefly outside the labrum glenoidale so that this lies more or less completely within the joint cavity. The capsule is attached to the femur in front close above the linea intertrochanterica, behind to the neck of the femur medianward from the crista intertrochanterica in a line parallel to the latter so that somewhat more than the medial half of the posterior surface of the neck of the femur looks into the joint capsule. The stratum synoviale of the capsule is continued upon the ligamentum teres and encloses this like a sheath. The fossa acetabuli is almost completely filled up by masses of fat, synovial villi and the ligamentum teres.


Ligamentum transversum genus
Tuberositas tibiae
Meniscus medialis
Meniscus lateralis
Ligamentum cruciatum anterius
Ligamentum cruciatum posterius

304. Right knee joint, *articulatio genus.*

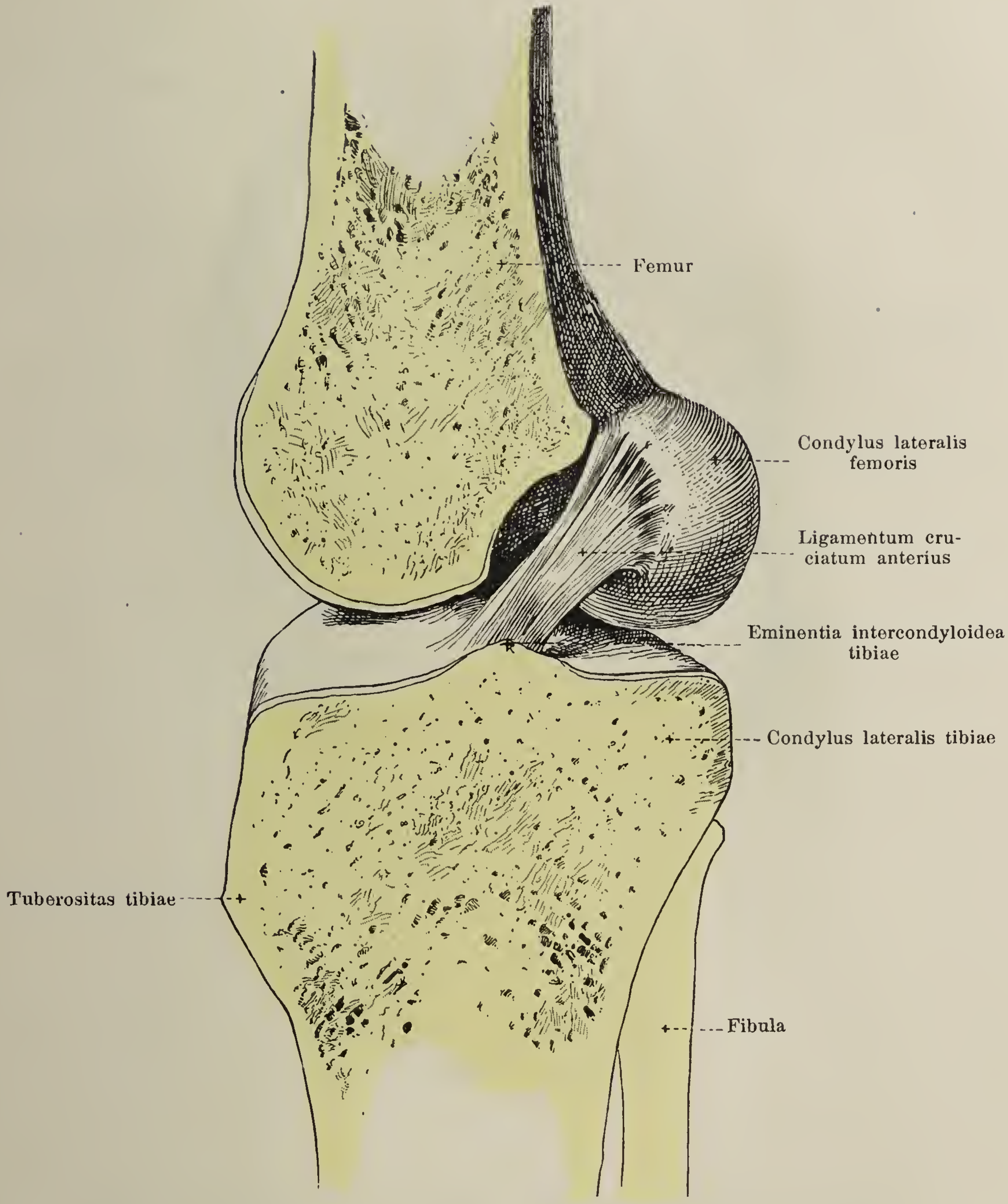
Tibia with cartilaginous discs, from above.

The articulated connection between the thigh bones, **articulatio genus** *(knee joint)* (see also Figs. 305—312), arises from the fact that the two condyli femoris move upon the condyli tibiae. Within the *capsula articularis* enclosing the joint, between the two bones, two sickle-shaped connective tissue discs are intercalated, the *meniscus lateralis* and the *meniscus medialis* (see also Figs. 306—308 and 311.) These are firmly connected at their extremities, by connective tissue strands with the tibia. Each meniscus is triangular on cross-section (see Fig. 311); its two smooth sides lie one on the appertaining condylus tibiae, the other on the condylus femoris; these two sides meet in a sharp, concave margin; its third, narrowest side is directed toward the outer circumference of the joint and is fused with its capsule.

The *meniscus lateralis* (O. T. external semilunar fibrocartilage) is somewhat shorter and more circular; it arises anteriorly (see also Fig. 224) close in front of the eminentia intercondyloidea tibiae, directly in front of the tuberculum intercondyloideum laterale, and is fastened by its posterior extremity to the posterior slope of the eminentia intercondyloidea, chiefly to the tuberculum intercondyloideum laterale, and a part of its bundles of fibres to the tuberculum intercondyloideum mediale.

The *meniscus medialis* (O. T. internal semilunar fibrocartilage) is longer, broader, slightly bent and more sickle-shaped (see also Fig. 224); it arises anteriorly in front of the fossa intercondyloidea anterior from the margo infraglenoidalis and is attached behind in the fossa intercondyloidea posterior.

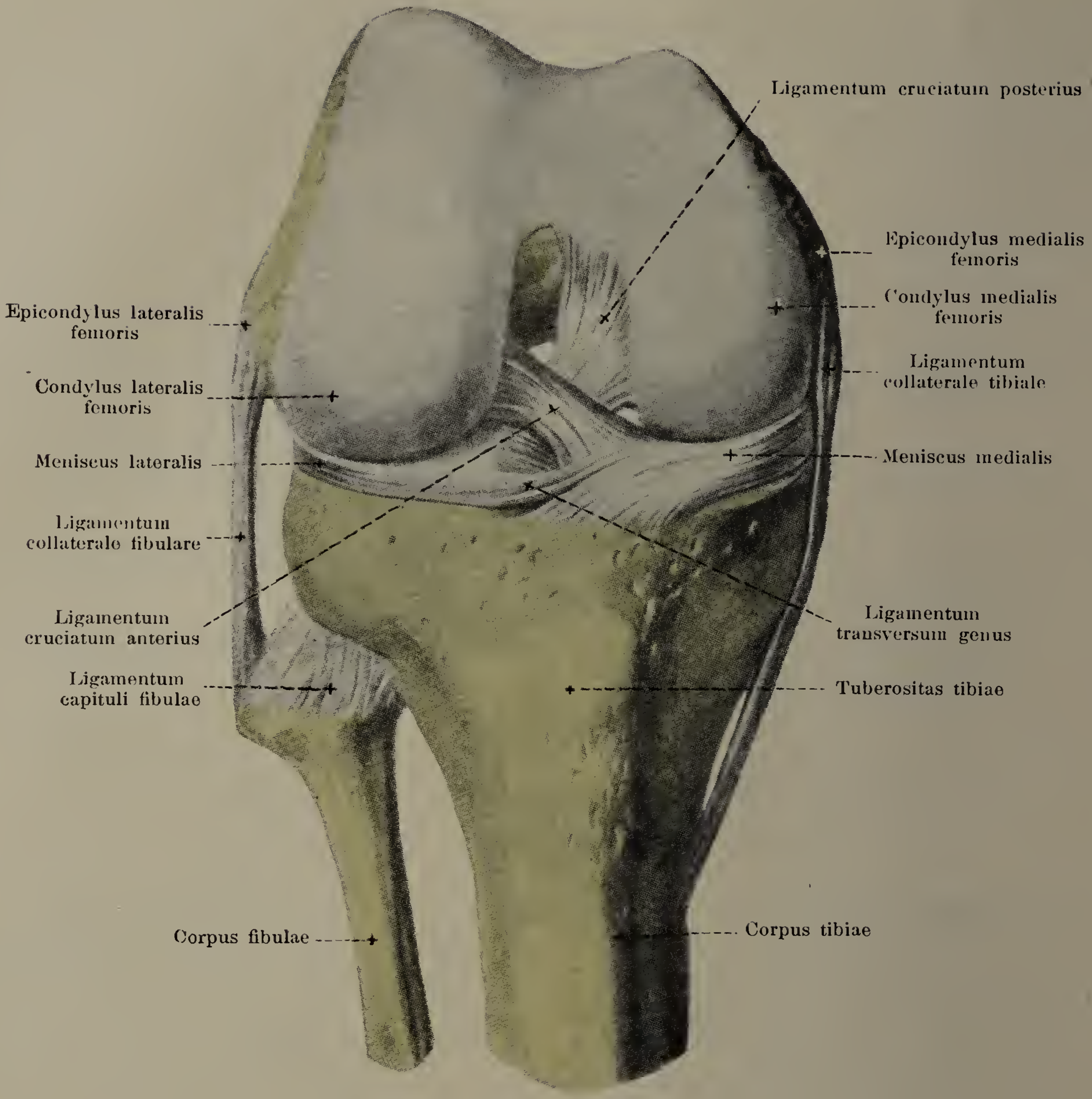
Between the most anterior points of the two menisci is stretched out the thin rounded *ligamentum transversum genus* (see also Figs. 306 and 307), which is composed of connective tissue, which pretty frequently is poorly developed and often is absent altogether.


Femur
Condylus lateralis femoris
Ligamentum cruciatum anterius
Eminentia intercondyloidea tibiae
Condylus lateralis tibiae
Tuberositas tibiae
Fibula

305. Right knee joint, *articulatio genus.*
Sagittal section at about the middle of the joint. Lateral half, viewed from the medial side; somewhat schematic.

(The meniscus lateralis has been removed.)

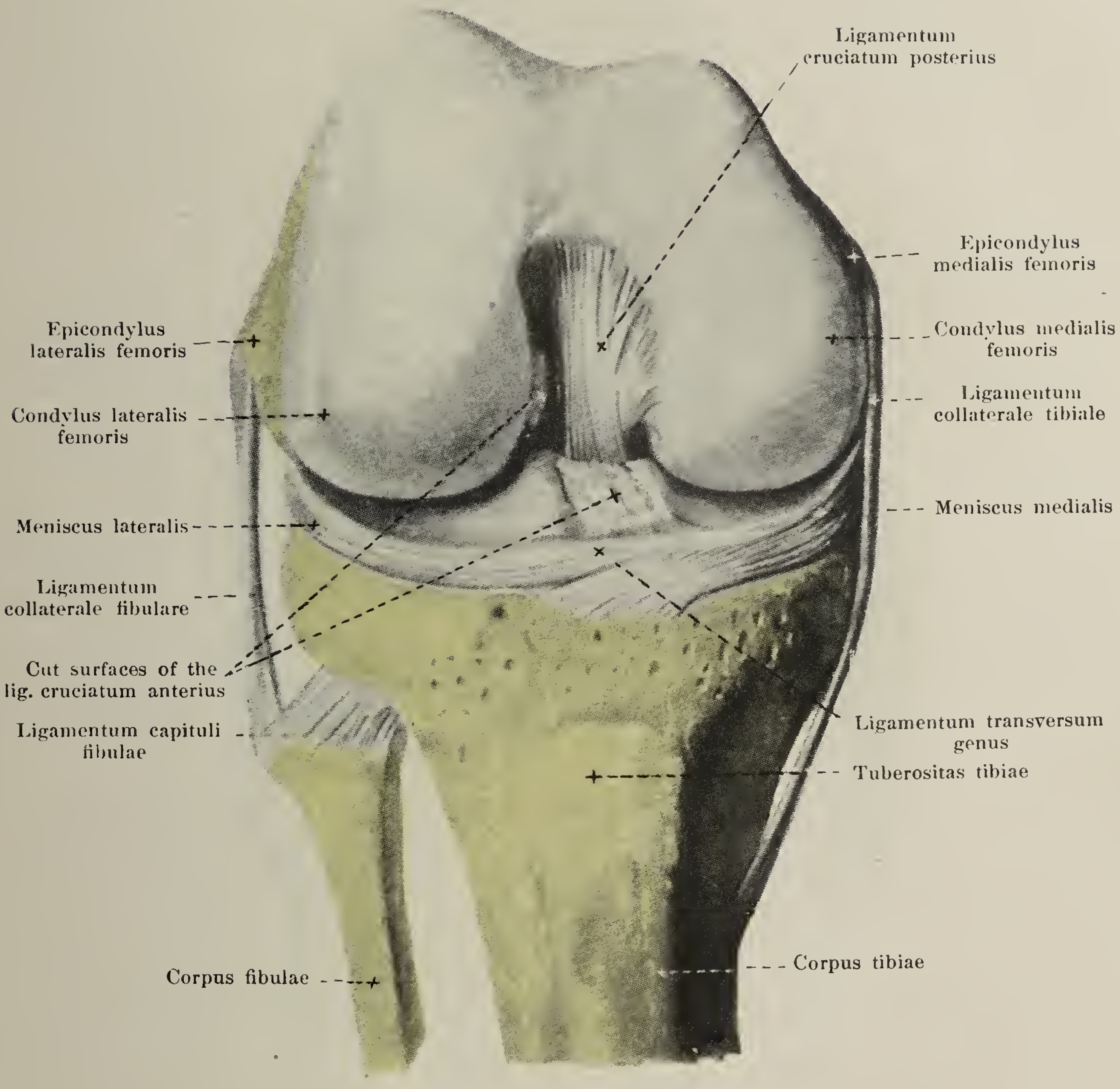
Articulatio genus (continued) (see also Figs. 304, 306—308 and 310). It has inside it the *ligamenta cruciata genus anterius et posterius.* Each of these goes from the surface turned toward the fossa intercondvloidea of one condylus femoris downward to the region of the eminentia intercondyloidea tibiae; in the extended position the anterior ligament is directed obliquely forward, the posterior somewhat obliquely backward. Together they assume the form of an X and are connected by loose connective tissue and fat not only with one another, but also with the posterior wall of the capsula articularis. They are ensheathed by the synovial membrane.


Ligamentum cruciatum posterius
Epicondylus medialis femoris
Condylus medialis femoris
Ligamentum collaterale tibiale
Meniscus medialis
Ligamentum transversum genus
Tuberositas tibiae
Corpus tibiae
Epicondylus lateralis femoris
Condylus lateralis femoris
Meniscus lateralis
Ligamentum collaterale fibulare
Ligamentum cruciatum anterius
Ligamentum capituli fibulae
Corpus fibulae

306. Right knee joint, *articulatio genus,*
from in front.

(The knee is flexed at a right angle; the patella and the capsule of the joint have been removed.)

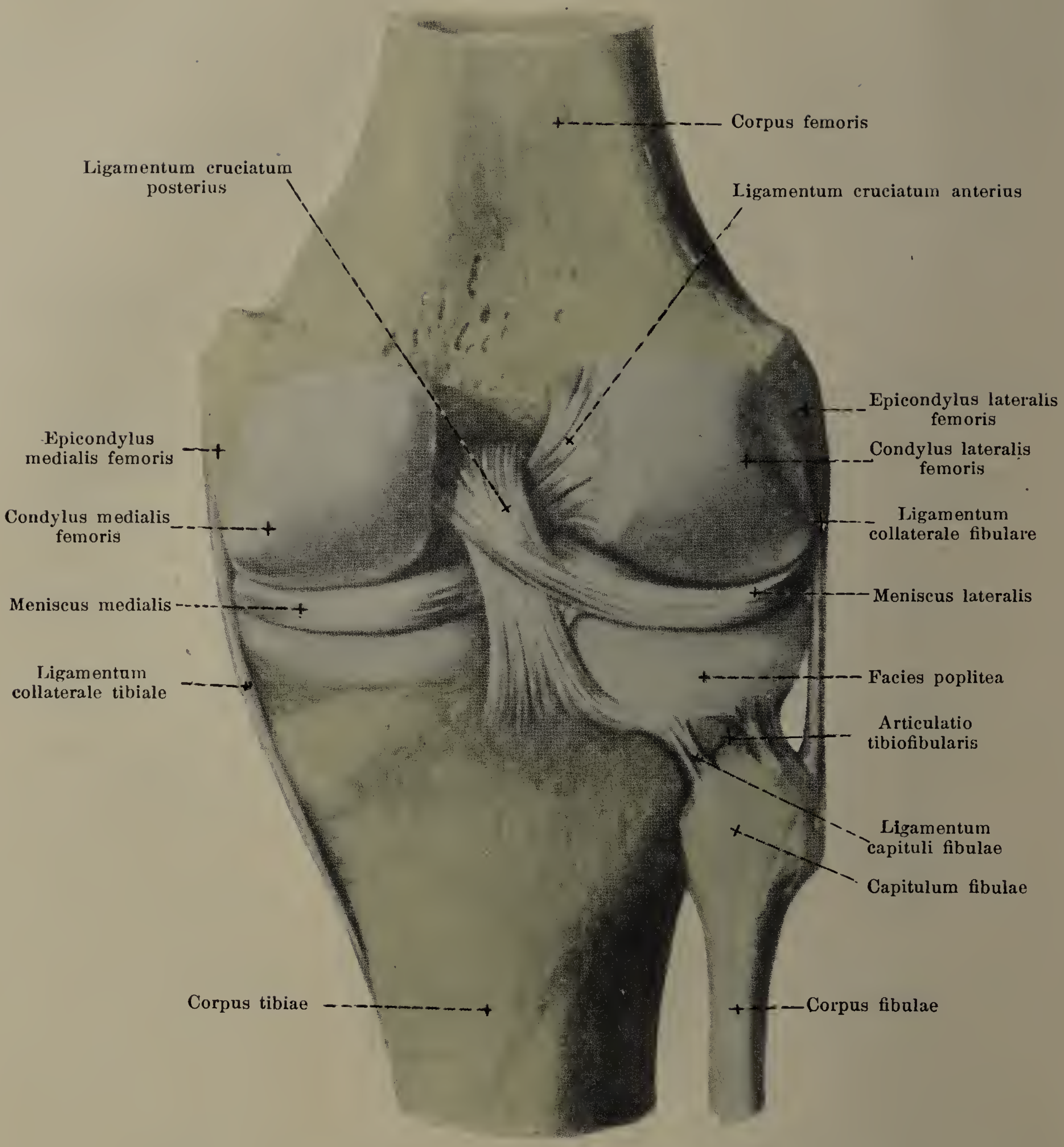
Articulatio genus (continued) (see also Figs. 304, 305 and 308). The *ligamentum cruciatum anterius* (O. T. anterior or external crucial ligament) has a broad origin on the non-cartilaginous, medial surface of the condylus lateralis femoris, near its posterior margin. From there on it becomes narrower, passes as a flatly rounded bundle obliquely forward, downward and medianward and is attached especially to the tuberculum intercondyloideum mediale and in the fossa intercondyloidea anterior tibiae, between the anterior points of fastening of the two menisci (see also Figs. 224 and 304).


Ligamentum cruciatum posterius
Epicondylus medialis femoris
Epicondylus lateralis femoris
Condylus medialis femoris
Ligamentum collaterale tibiale
Condylus lateralis femoris
Meniscus medialis
Meniscus lateralis
Ligamentum collaterale fibulare
Cut surfaces of the lig. cruciatum anterius
Ligamentum transversum genus
Ligamentum capituli fibulae
Tuberositas tibiae
Corpus tibiae
Corpus fibulae

307. Right knee joint, *articulatio genus,*
from in front.

(The knee is flexed at a right angle; the patella and the capsule of the joint have been removed, the ligamentum cruciatum anterius has been cut off short at its points of attachment.)

Articulatio genus (continued) (see also Figs. 304—306 and 308—312). The *ligamentum cruciatum posterius* (O. T. posterior or internal crucial ligament) lies behind the ligamentum cruciatum anterius, crosses the same and is somewhat stronger. It has a broad origin from the lateral surface of the condylus medialis femoris close to its anterior and inferior margin, narrows to a flatly rounded cord and passes somewhat obliquely downward, backward, and lateralward to the fossa intercondyloidea posterior tibiae and to the posterior surface of the tibia, behind the posterior points of fastening of the two menisci (see also Figs. 224, 304 and 308); one band of fibres, arising in the medial portion, runs behind the ligament obliquely lateralward to the posterior part of the meniscus lateralis (see Fig. 308).


Corpus femoris
Ligamentum cruciatum posterius
Ligamentum cruciatum anterius
Epicondylus lateralis femoris
Epicondylus medialis femoris
Condylus lateralis femoris
Condylus medialis femoris
Ligamentum collaterale fibulare
Meniscus medialis
Meniscus lateralis
Ligamentum collaterale tibiale
Facies poplitea
Articulatio tibiofibularis
Ligamentum capituli fibulae
Capitulum fibulae
Corpus tibiae
Corpus fibulae

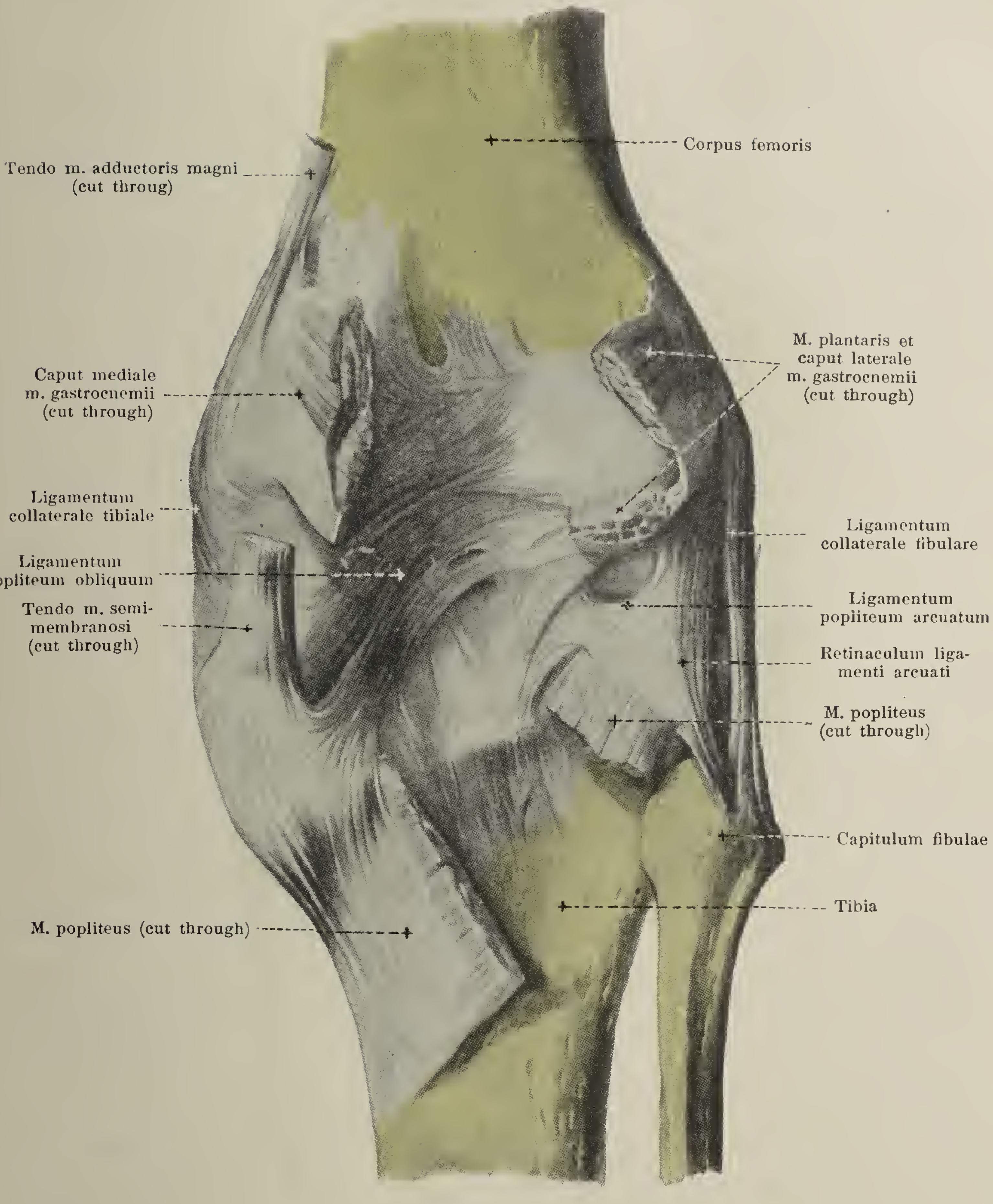
308. Right knee joint, ***articulatio genus,*** from behind.

(The capsule, except for the strengthening ligaments, has been removed.)

Articulatio genus (continued) (see also Figs. 304—307 and 309—312). The ligaments which serve to strengthen the capsule laterally are called the ***ligamenta collateralia fibulare et tibiale.*** They are stretched out tight when the knee is extended and slacken when it is flexed; this is clearer in the fibular ligament than in the tibial.

The ***ligamentum collaterale fibulare*** (O. T. long external lateral ligament) is a rounded fibrous cord which extends from the epicondylus lateralis femoris to the lateral surface of the capitulum fibulae. It is separated by fatty tissue from the capsule of the joint and by the tendon of the m. popliteus and the bursa m. poplitei from the meniscus lateralis.

The ***ligamentum collaterale tibiale*** (O. T. internal lateral ligament) is a broader, flat ligament which extends from the epicondylus medialis femoris to the medial portion of the margo infraglenoidalis tibiae and thence farther downward. It is interwoven in the wall of the capsule and is partly attached also to the meniscus medialis. Below the margo infraglenoidalis it covers the extremity of the tendon of the m. semimembranosus and the a. genus inferior medialis, which lies directly upon the bone.


Corpus femoris
Tendo m. adductoris magni (cut throug)
M. plantaris et caput laterale m. gastrocnemii (cut through)
Caput mediale m. gastrocnemii (cut through)
Ligamentum collaterale tibiale
Ligamentum collaterale fibulare
Ligamentum popliteum obliquum
Ligamentum popliteum arcuatum
Tendo m. semimembranosi (cut through)
Retinaculum ligamenti arcuati
M. popliteus (cut through)
Capitulum fibulae
Tibia
M. popliteus (cut through)

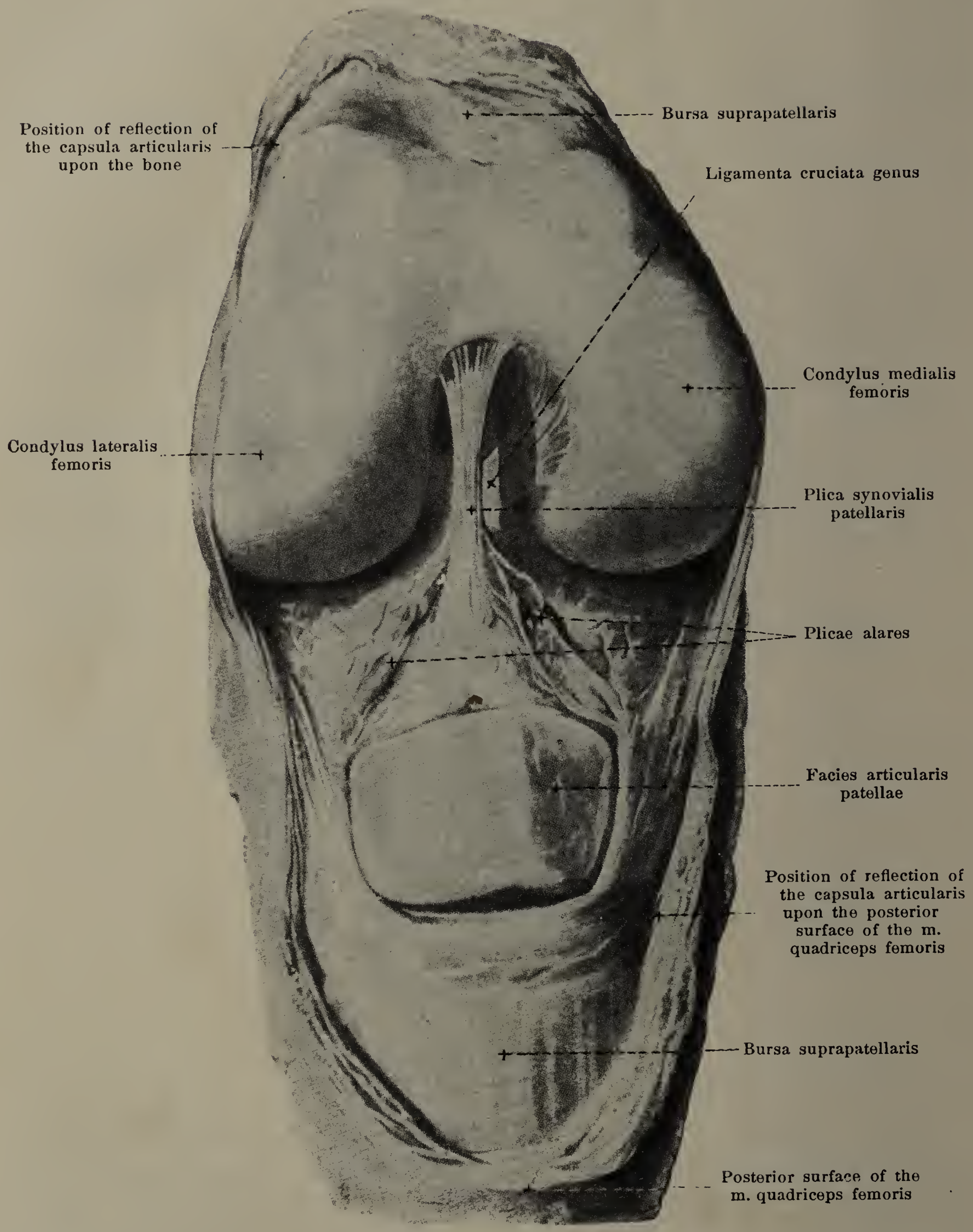
309. Right knee joint, ***articulatio genus,*** from behind.

(The muscles partially fused with the capsule have been cut off, close to their attachment.)

Articulatio genus (continued) (see also Figs. 304—308 and 310—312). It has, on the posterior surface, the following strengthening ligaments:

The powerful, flat *ligamentum popliteum obliquum* (O. T. posterior ligament) extends from the region of the condylus lateralis femoris obliquely medianward and downward; its fibres become lost, partially descending in the wall of the capsule and in the fascia of the m. popliteus, partially by bending around upward and going over into the tendon of the m. semimembranosus.

The *ligamentum popliteum arcuatum* is a somewhat variable, usually horse-shoe shaped band of fibres, concave above, which arises in the region of the epicondylus lateralis femoris and becomes lost in the middle of the posterior wall of the capsule below the ligamentum popliteum obliquum. From the convex circumference of the ligament the *retinaculum ligamenti arcuati* goes off with two converging limbs; it has a narrow attachment to the capitulum fibulae; from the same place also a part of the m. popliteus arises.

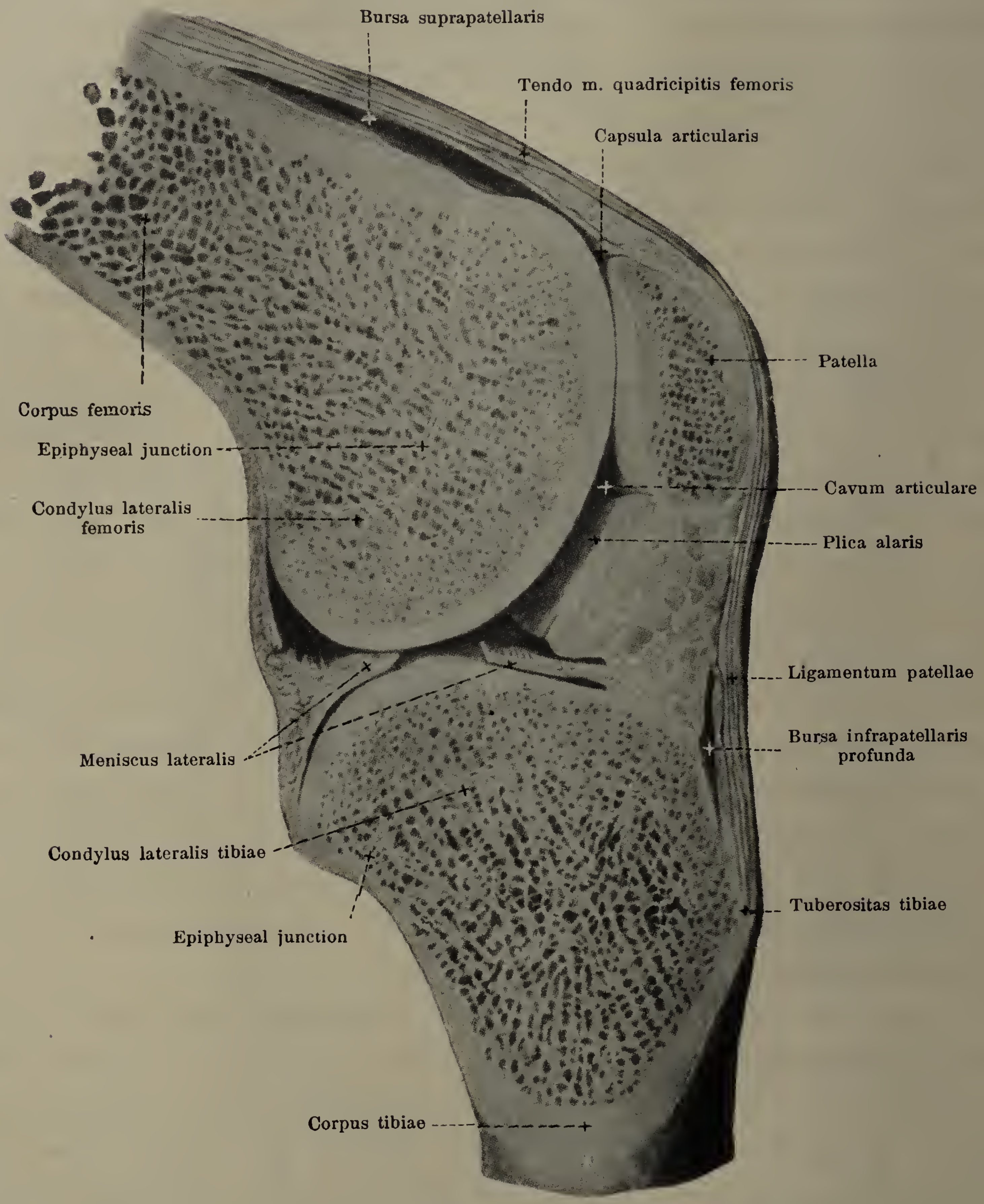

Position of reflection of the capsula articularis upon the bone
Bursa suprapatellaris
Ligamenta cruciata genus
Condylus medialis femoris
Condylus lateralis femoris
Plica synovialis patellaris
Plicae alares
Facies articularis patellae
Position of reflection of the capsula articularis upon the posterior surface of the m. quadriceps femoris
Bursa suprapatellaris
Posterior surface of the m. quadriceps femoris

310. Right knee joint, ***articulatio genus,*** from in front.

(After cutting through the capsula articularis close to the bone the tendinous expansion of the m. quadriceps femoris along with the patella have been turned down in front; the knee is flexed.)

Articulatio genus (continued) see also Figs. 304—309, 311 and 312). The *capsula articularis* (see also Figs. 311 and 312) extends over the posterior surface of the common tendon of the m. quadriceps femoris in front close above the patella and goes over at the border of the patella upon the latter so that the whole facies articularis patellae looks into the joint cavity. Thence the capsule runs as a loose membrane separated by abundant fatty tissue from the ligamentum patellae and from the adjoining parts of the retinacula patellae to the upper margins of the two menisci and to the inferior attachment of the ligamentum cruciatum anterius. It then encloses the two ligamenta cruciata genus in a common sheath and goes over at the posterior margin of the ligamentum cruciatum posterius into the posterior wall. From the medial and lateral margin of the facies articularis patellae project two prominent, fatty, synovial folds, *plicae alares* (O. T. ligamenta alaria) which converge below; they are often studded with synovial villi. At the angle of union of the same there arises a very variable, simple, larger, often fatty, fold, the *plica synovialis patellaris* (O. T. ligamentum mucosum), which extends backward, in a sagittal direction, free through the joint cavity to become attached at the lowermost margin of the fossa intercondyloidea femoris; it is the anterior margin of a large sagittal fold of the synovial membrane, originally present in fetus, ensheathing the ligamenta cruciata and extending from the posterior capsular wall, without interruption, as far as the patella; this fold divides the joint cavity from behind into two compartments, corresponding to the two pairs of condyli of the femur and of the tibia, communicating in front of the fold. This original condition may be preserved wholly or in part; usually the posterior part containing the ligamenta cruciata from the most anterior part, the plica synovialis patellaris, is separated by a gap.

The joint cavity is continued upward in the majority of cases directly into the *bursa [mucosa] suprapatellaris*. This large bursa, the upper edge of which, when the knee is extended, continues upward 4 centimetres or still higher above the upper edge of the patella, lies between the anterior surface of the lower end of the femur which has only a slight covering of fat and the posterior surface of the common tendon of the m. quadriceps femoris (see Figs. 311 and 312), and is intimately fused with the latter; it is separated from the joint cavity, usually only incompletely and indistinctly, by a projecting fold (see Fig. 312). In the fetus the bursa is completely shut off so that no connection exists between the two cavities, and it then becomes displaced for a variable distance from above downward in front of the capsule of the joint. This condition remains in adults in about 15 % of the cases.



311. Right knee joint, ***articulatio genus.***

Sagittal section through the condylus lateralis femoris.

Medial half of section, from the lateral side.

(The knee is slightly flexed; the joint surfaces have been pulled a little apart.)

Articulatio genus (continued) (see also Figs. 304—310 and 312). The *capsula articularis* passes in front from the posterior surface of the tendon of the m. quadriceps femoris (see p. 229) to the anterior surface of the femur above the joint tuberosities. The fold of the capsule at the sides runs near the margin of the cartilaginous coating, so that the region of the epicondyli remains free (see Fig. 312); the capsule therefore covers the cartilaginous surfaces and a part of the anterior surface of the femur which is not covered by cartilage. (see also Figs. 310 and 312).

To the tibia the capsule is attached around the margo infraglenoidalis, a little below the margin of the cartilaginous surfaces; thence it goes to the lower margin of each of the two menisci, lines its lower and upper surfaces and from its upper margin passes in front to the posterior surface of the patella and of the tendon of the m. quadriceps femoris (see p. 229), laterally and behind to the point of reflection on the femur.

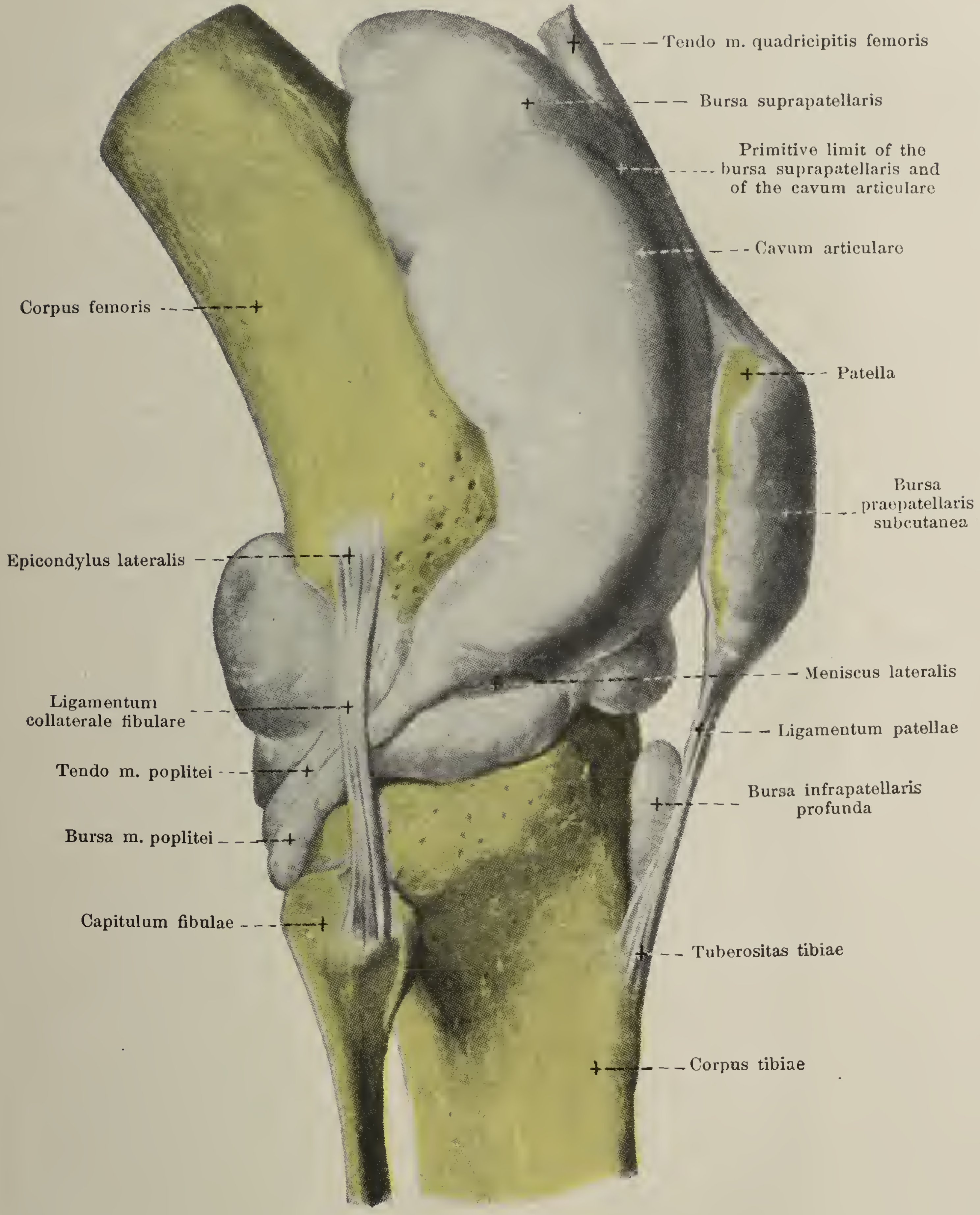
The *ligamentum patellae* (see also Fig. 312) is a flat, very strong ligament which goes off from the lower margin and the anterior surface of the patella and, narrowing slightly, becomes attached to the tuberositas tibiae (see also Fig. 224); it is separated from the capsula articularis by thick masses of fat. The ligament is partially a direct continuation of the tendinous fibres of the m. quadriceps femoris running over the patella and can accordingly be considered mechanically as the terminal tendon of this muscle; in this sense the patella itself has to be thought formerly as a large sesamoid bone intercalated in this tendon and acts also in such a manner functionally. It goes a litle oblique downward and lateralward when the knee is extended, exactly downward when it is flexed.

Articulatio genus (continued) (see also Figs. 304—311). The *cavum articulare* is in open communication regularly with the *bursa [mucosa] musculi poplitei* (see also Fig. 447). This tube-like pocket extends downward and backward on the lateral side in front of and below the tendon of origin of the m. popliteus and may reach till behind the articulatio tibiofibularis; it opens into the joint by a narrow slit above the meniscus lateralis, between this and the tendon of the m. popliteus, but possesses usually in addition a second communicating opening below the meniscus; it communicates sometimes also with the articulatio tibiofibularis.

In front of the patella are three bursae: the *bursa praepatellaris subcutanea* in the subcutaneous connective tissue in front of the fascia lata (see also Fig. 426), the *bursa praepatellaris subfascialis* (not figured) behind the fascia lata, between it and the tendinous expansion of the m. quadriceps femoris, and the *bursa praepatellaris subtendinea* between the tendon of the m. quadriceps and the anterior surface of the patella (not figured). In most cases these bursae praepatellares occur all three, sometimes manifoldly; at times all three or only two of them communicate freely with one another; the size of these bursae differs much. They never communicate with the joint cavity.

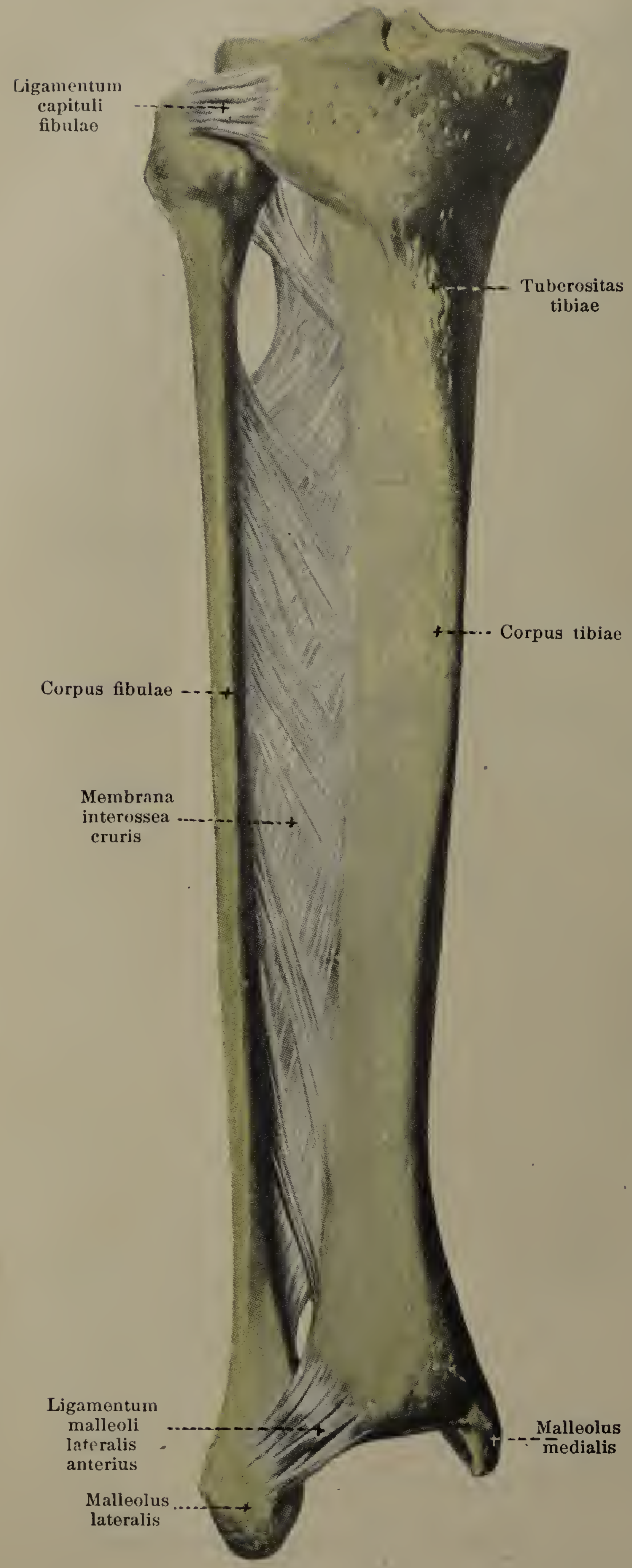
The *bursa infrapatellaris profunda* (see also Fig. 311) lies between the posterior surface of the ligamentum patellae and the anterior surface of the tibiae. It is separated from the cavity of the knee joint by masses of fat and communicates with it only very rarely.

The joint cavity is connected, in addition, in most cases, with the *bursa suprapatellaris* (see p. 229), very often with a *bursa m. semimembranosi* (see p. 366) or with the *bursa m. gastrocnemii medialis* (see p. 367), often also with the *bursa m. gastrocnemii lateralis* (see p. 368).



312. Right knee joint, ***articulatio genus,***
from the lateral surface.

(The joint cavity and several bursae have been injected with a stiffening medium and then dissected out.)


Ligamentum capituli fibulae
Tuberositas tibiae
Corpus tibiae
Corpus fibulae
Membrana interossea cruris
Ligamentum malleoli lateralis anterius
Malleolus medialis
Malleolus lateralis

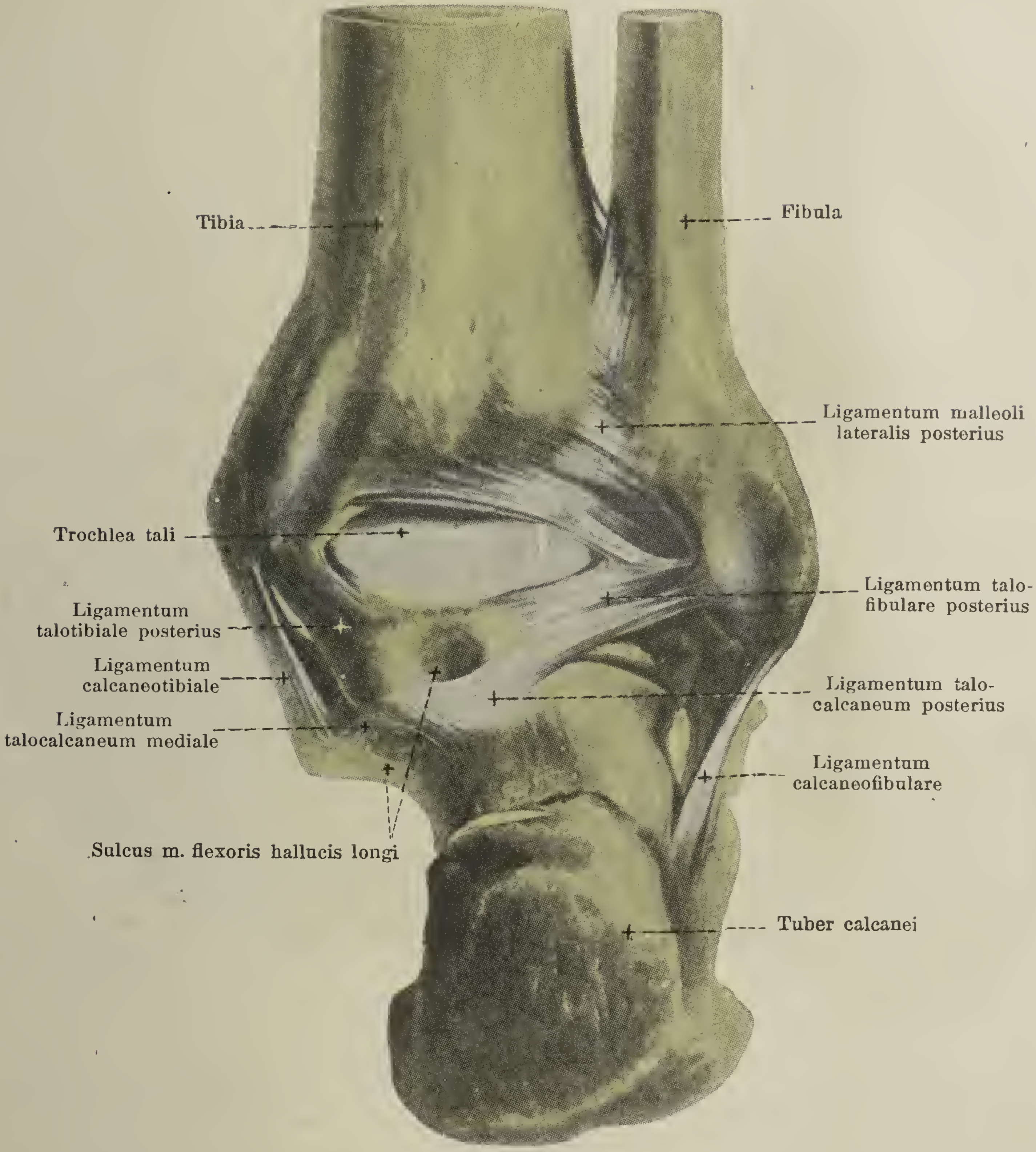
313. Ligaments of the right leg, from in front.

The tibia and fibula are united by two joints, one above and one below, besides throughout nearly their whole length by the membrana interossea cruris.

The **articulatio tibiofibularis** (O. T. superior tibiofibular articulation) (see also Figs. 306—308) arises through the apposition of the facies articularis capituli fibulae to the facies articularis fibularis tibiae. The tight *capsula articularis* arises from both bones generally close to the margin of the cartilaginous surface. On the anterior surface and often also on the posterior, a strengthening ligament, the *ligamentum capituli fibulae* (O. T. anterior and posterior superior tibiofibular ligaments), runs transversely or somewhat obliquely lateralward and downward. In addition the ligamentum collaterale fibulare and the retinaculum ligamenti arcuati of the knee joint are to be regarded as strengthening ligaments (in the wider sense) for the articulatio tibiofibularis. The joint communicates sometimes with the bursa [mucosa] m. poplitei and through this indirectly with the knee joint.

The **membrana interossea cruris** (O. T. middle tibiofibular ligament or interosseous membrane) is stretched out as a broad lamella between the cristae interosseae of the tibia and fibula. The fibres usually assume a course descending toward the fibula. Above, between the membrane and the articulatio tibiofibularis, there remains a large opening for the passage of vessels and nerves.

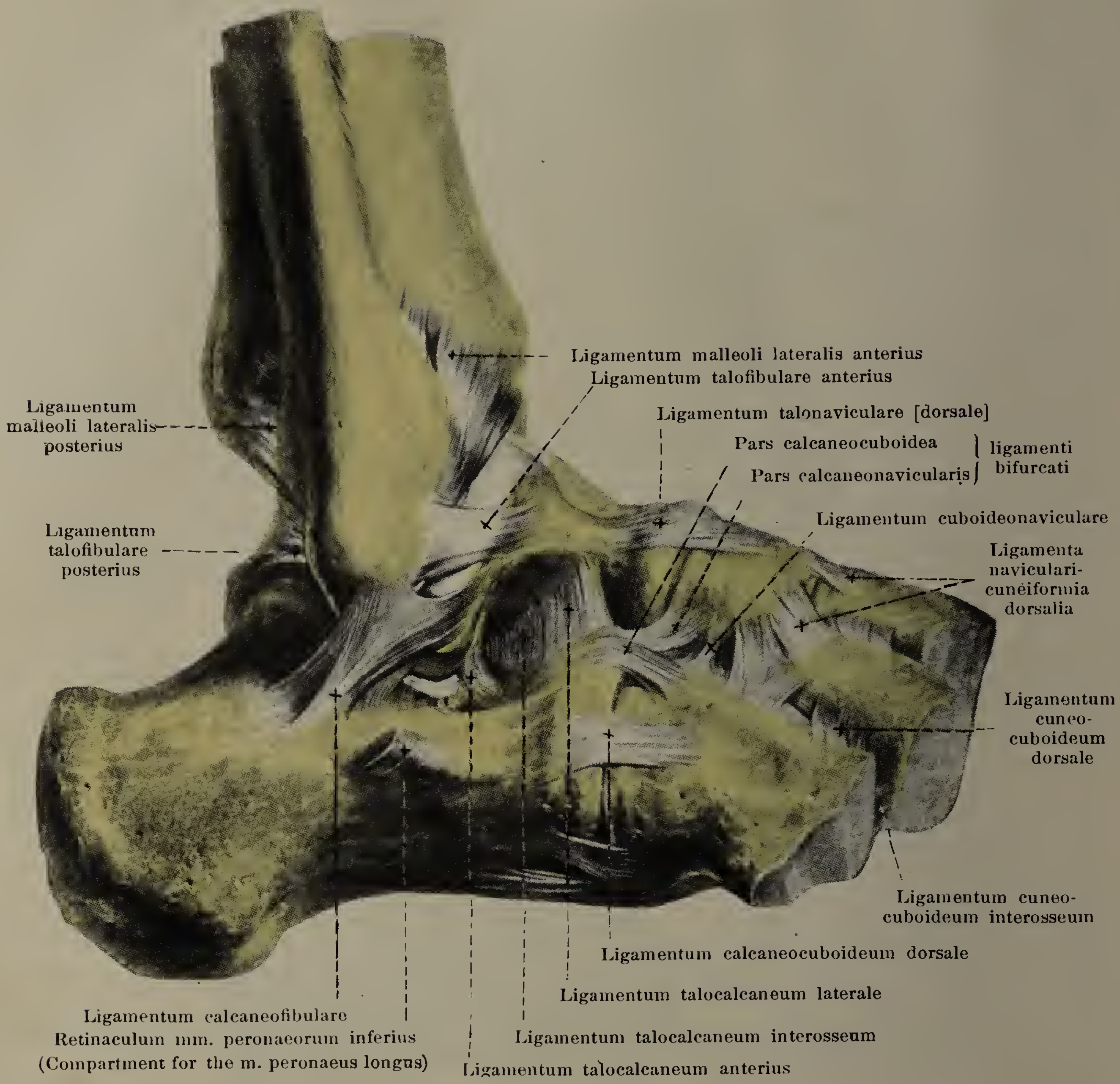
The **syndesmosis tibiofibularis** (O. T. inferior tibiofibular articulation) (see also Figs. 314, 315 and 322) is the movable union between the medial surface of the malleolus lateralis (above the facies articularis malleoli lateralis) and the incisura fibularis tibiae. The bony surfaces opposed to one another are covered only sometimes in their most anterior portion by hyaline cartilage, otherwise always by periosteum with a fatty substratum in parts; between the two, projecting upward from the articulatio talocruralis is a small slit-shaped pocket. In front and behind strong ligaments run transversely over the joint, the *ligamenta malleoli lateralis.* The *ligamentum malleoli lateralis anterius* extends as a flat cord from the region in front of the incisura fibularis tibiae obliquely lateralward and downward to the anterior surface of the malleolus lateralis.


Tibia
Fibula
Ligamentum malleoli lateralis posterius
Trochlea tali
Ligamentum talofibulare posterius
Ligamentum talotibiale posterius
Ligamentum calcaneotibiale
Ligamentum talocalcaneum posterius
Ligamentum talocalcaneum mediale
Ligamentum calcaneofibulare
Sulcus m. flexoris hallucis longi
Tuber calcanei

314. Joints of the right foot, ***articulationes pedis,*** from behind.
(The capsulae articulares have been removed except for the strengthening ligaments.)

Syndesmosis tibiofibularis (continued). The ***ligamentum malleoli lateralis posterius*** has a broad origin from the region behind the incisura fibularis tibiae and from the posterior margin of the facies articularis inferior tibiae and goes obliquely downward to the posterior surface of the malleolus lateralis; its lower fibres are united with the ligamentum talofibulare posterius, and help to enlarge and deepen the joint cavity for the trochlea tali.

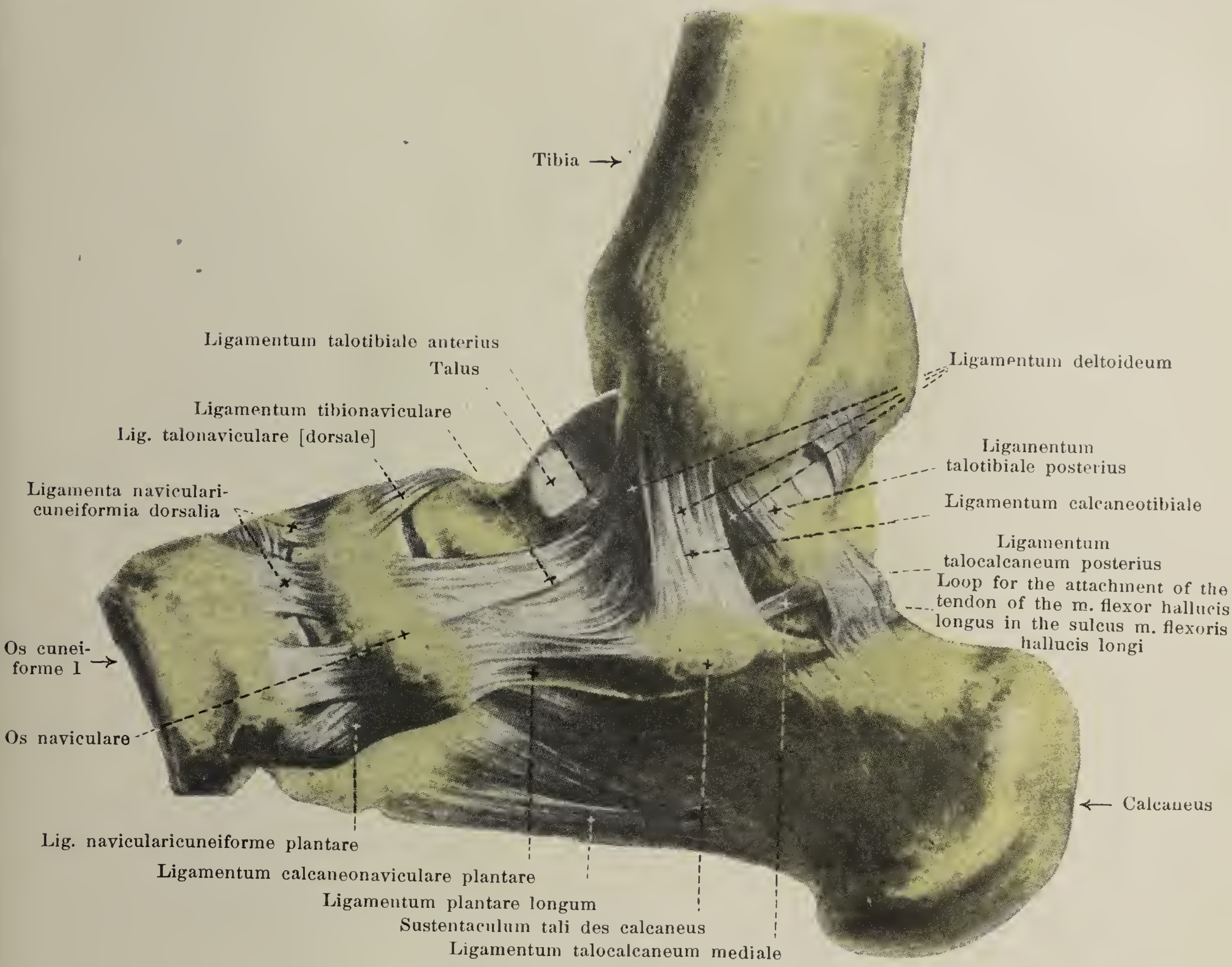
The foot is movably united with the leg bones by the **articulatio talocruralis** *(ankle-joint)* (see also Figs. 315 and 316); it arises from the fact that the trochlea tali moves in the joint cavity formed by the distal end-pieces of the tibia and fibula; here the facies superior tali glides upon the facies articularis inferior tibiae, the facies malleolaris lateralis tali upon the facies articularis malleoli lateralis [fibulae] and the facies malleolaris medialis tali upon the facies articularis malleoli medialis [tibiae]; the two malleoli thus embrace fork-shaped the trochlea tali from two sides. The ***capsula articularis*** arises everywhere close to the margin of the cartilaginous surface; only in front of the facies articularis superior tali goes it over also a part of the collum tali which is free from cartilage; at the sides the capsule is tight; in front front and behind it is looser. Very powerful strengthening ligaments (guiding ligaments), lateral as ***ligamentum talofibularia et calcaneofibulare*** (see page 236), medial as ***ligamentum deltoideum*** (see page 237), go from the two malleoli to the ankle bones.


Ligamentum malleoli lateralis anterius
Ligamentum talofibulare anterius
Ligamentum malleoli lateralis posterius
Ligamentum talonaviculare [dorsale]
Pars calcaneocuboidea
Pars calcaneonavicularis
ligamenti bifurcati
Ligamentum cuboideonaviculare
Ligamentum talofibulare posterius
Ligamenta naviculari-cuneiformia dorsalia
Ligamentum cuneo-cuboideum dorsale
Ligamentum cuneo-cuboideum interosseum
Ligamentum calcaneocuboideum dorsale
Ligamentum talocalcaneum laterale
Ligamentum calcaneofibulare
Retinaculum mm. peronaeorum inferius
(Compartment for the m. peronaeus longus)
Ligamentum talocalcaneum interosseum
Ligamentum talocalcaneum anterius

315. Joints of the right foot, ***articulationes pedis,***
from the lateral surface.

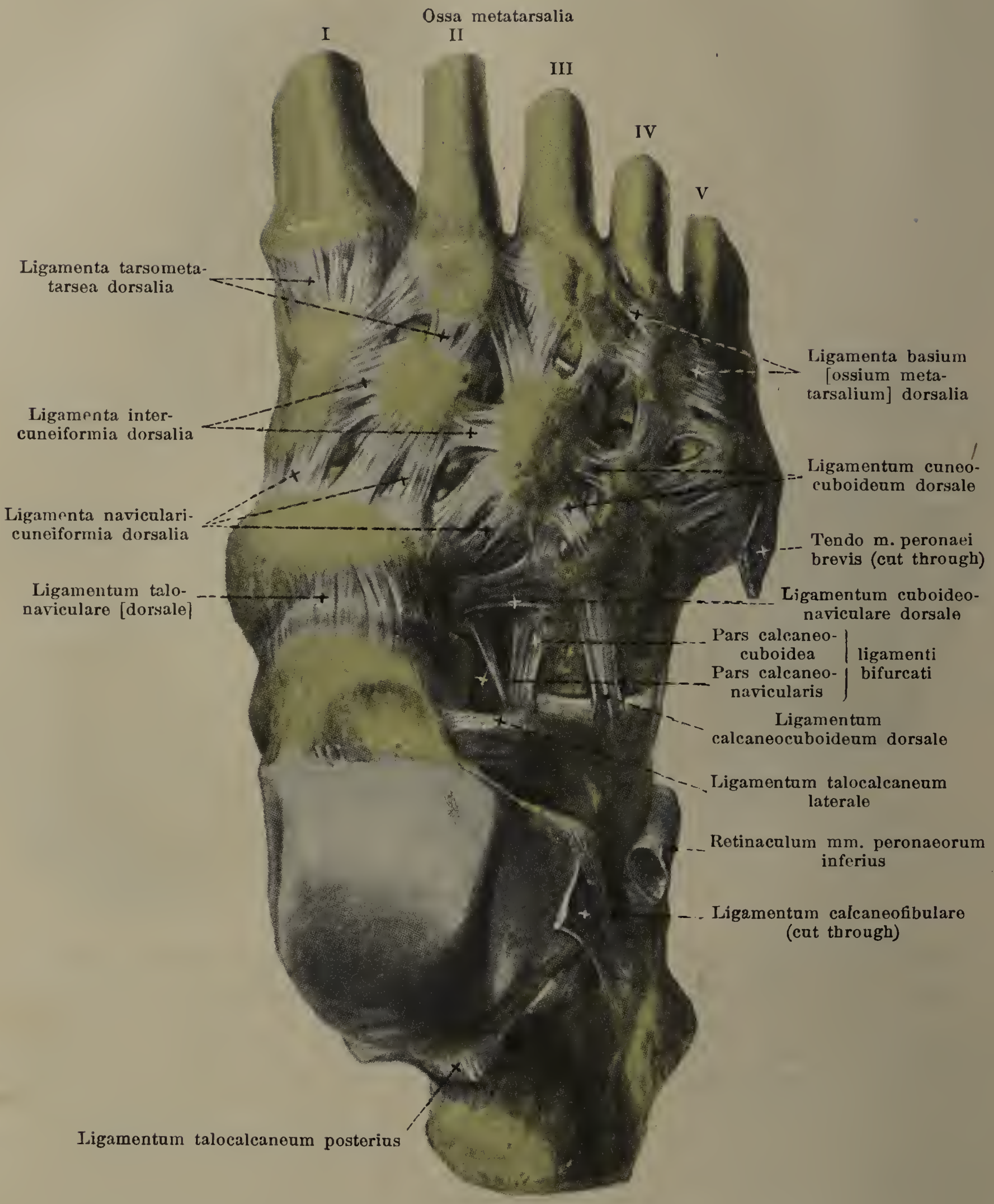
(The metacarpal bones have been removed as well as the capsulae articulares with the exception of their strengthening ligaments.)

Articulatio talocruralis (continuation). The *ligamentum talofibulare posterius* (O. T. posterior fasciculus of external lateral ligament) (see Fig. 314) arises at the malleolus lateralis [fibulae] behind the facies articularis malleoli lateralis and extends, flat, obliquely medianward and downward to the region of the lateral projection of the processus posterior tali. The *ligamentum talofibulare anterius* (O. T. anterior fasciculus of external lateral ligament) goes from the anterior surface of the malleolus lateralis medianward to the lateral surface of the collum tali. The *ligamentum calcaneofibulare* (O. T. middle fasciculus of external lateral ligament) (see also Figs. 314 and 317) runs as a flat-rounded cord from the tip of the malleolus lateralis obliquely downward and backward to the lateral surface of the calcaneus; its outer surface forms a shallow groove in which glide the tendons of the mm. peronaei.


Tibia
Ligamentum talotibiale anterius
Talus
Ligamentum tibionaviculare
Lig. talonaviculare [dorsale]
Ligamenta naviculari-cuneiformia dorsalia
Os cuneiforme 1
Os naviculare
Ligamentum deltoideum
Ligamentum talotibiale posterius
Ligamentum calcaneotibiale
Ligamentum talocalcaneum posterius
Loop for the attachment of the tendon of the m. flexor hallucis longus in the sulcus m. flexoris hallucis longi
Calcaneus
Lig. navicularicuneiforme plantare
Ligamentum calcaneonaviculare plantare
Ligamentum plantare longum
Sustentaculum tali des calcaneus
Ligamentum talocalcaneum mediale

316. Joints of the right foot, *articulationes pedis,* **from the medial surface.** (The specimen has been prepared as for Fig. 315.)

Articulatio talocruralis (continued). The *ligamentum deltoideum* (O. T. deltoid or internal lateral ligament + the anterior and posterior tibiotarsal ligaments) is an unequalsided quadrangular ligamentous mass which has its origin on the medial surface of the malleolus medialis [tibiae] and has a broad attachment to the talus, calcaneus and os naviculare. This ligament is composed of several layers and is divisible, according to the lower attachments of its fibres, into the *ligamenta talotibialia,* the *ligamentum calcaneotibiale* and the *ligamentum tibionaviculare.* The *ligamentum talotibiale posterius* (O. T. posterior tibiotarsal ligament) (see also Fig. 314) is a thick, broad band of fibres which arises behind the tip of the malleolus medialis and is attached to the talus close behind and below the facies malleolaris medialis of the trochlea tali, in front of the medial projection of the processus posterior tali. The *ligamentum talotibiale anterius* (O. T. anterior tibiotarsal ligament), for the most part hidden below the ligamenta calcaneotibiale and tibionaviculare, is short and narrow and goes off from the anterior edge of the malleolus-medialis in front of the preceding and has a somewhat broad attachment below the anterior portion of the facies malleolaris medialis of the trochlea tali. The *ligamentum calcaneotibiale* (O. T. internal lateral ligament) (see also Fig. 314), the most superficial part of the ligamentum deltoideum, has a broad origin on the medial surface of the malleolus medialis near its inferior extremity and runs downward to the posterior margin of the sustentaculum tali of the calcaneus. The *ligamentum tibionaviculare* has a broad attachment to the anterior margin and the tip of the malleolus medialis just above the ligamentum talotibiale anterius and, broadening, goes to the dorsal and medial surface of the os naviculare as well as to the medial margin of the ligamentum calcaneonaviculare plantare; at its origin and behind it is partially hidden beneath the ligamentum calcaneotibiale. The medial surfaces of the ligamenta talotibiale posterius and calcaneotibiale form a groove for the tendon of the m. tibialis posterior.


Ossa metatarsalia
I
II
III
IV
V
Ligamenta tarsometatarsea dorsalia
Ligamenta intercuneiformia dorsalia
Ligamenta naviculari-cuneiformia dorsalia
Ligamentum talonaviculare [dorsale]
Ligamentum talocalcaneum posterius
Ligamenta basium [ossium metatarsalium] dorsalia
Ligamentum cuneocuboideum dorsale
Tendo m. peronaei brevis (cut through)
Ligamentum cuboideonaviculare dorsale
Pars calcaneocuboidea
Pars calcaneonavicularis
ligamenti bifurcati
Ligamentum calcaneocuboideum dorsale
Ligamentum talocalcaneum laterale
Retinaculum mm. peronaeorum inferius
Ligamentum calcaneofibulare (cut through)

317. Joints of the right foot, ***articulationes pedis,***
viewed from the back of the foot.

(The ossa metatarsalia have been sawed through in the middle, the capsulae articulares have been removed except for the strengthening ligaments.)

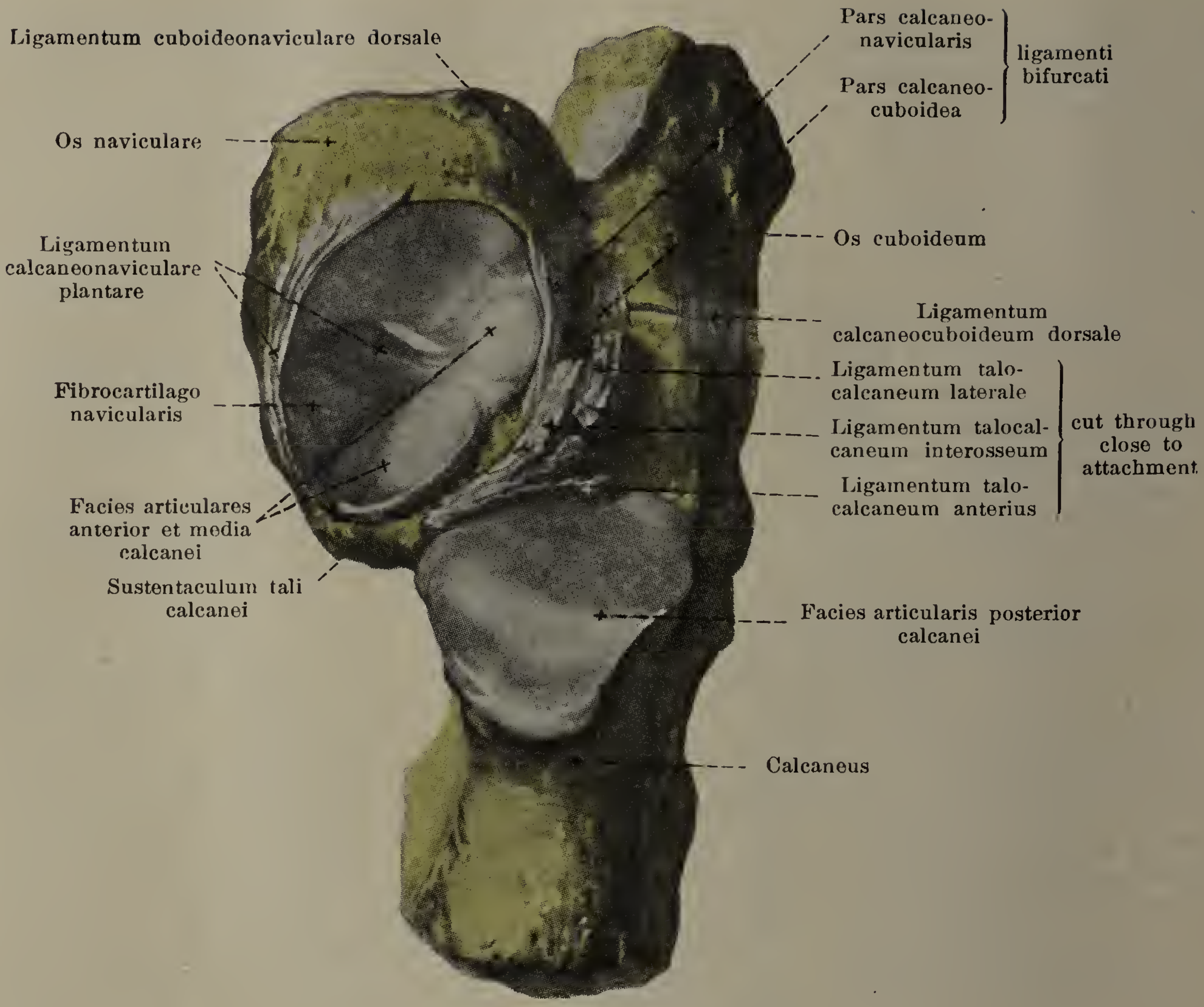
The tarsal bones can move upon one another by the **articulationes intertarseae** (O. T. articulations of the tarsus); these are formed by each individual tarsal bone being able to move with its cartilaginous joint surfaces upon the corresponding surfaces of the neighboring tarsal bones. The *capsulae articulares* of the individual joints thus arising (see p. 245) are strengthened usually by short fibrous bands, the *ligamenta talocalcanea* and the *ligamenta tarsi.*

Between the talus and the calcaneus are found five ***ligamenta talocalcanea*** (O. T. ligaments connecting the os calcis and the astragalus): (1) the *ligamentum talocalcaneum posterius* (O. T. posterior calcaneoastragaloid ligament) (see also Figs. 314 and 316) goes from the two projections of the processus posterior tali to the upper surface of the calcaneus immediately behind the facies articularis posterior and bridges over at its origin the sulcus m. flexoris hallucis longi of the talus; (2) the *ligamentum talocalcaneum anterius* (see Figs. 315 and 318) is a broad band of fibres which is stretched out in the sinus tarsi behind the ligamenta talocalcanea laterale et interosseum, on the anterior side of the articulatio talocalcanea (see p. 240), between the lower surface of the talus and the upper surface of the calcaneus, immediately in front of their facies articularis posterior; (3) the *ligamentum talocalcaneum mediale* (O. T. internal calcaneoastragaloid ligament) (see Figs. 314, 316 and 320) is a narrow bundle which extends from the medial tubercle of the processus posterior tali almost horizontally to the posterior margin of the sustentaculum tali of the calcaneus; (4) the *ligamentum talocalcaneum laterale* (O. T. external calcaneoastragaloid ligament) (see also Figs. 315 and 318) is the foremost one, has a broad origin from the lateral and inferior surface of the collum tali and runs at the entrance into the sinus tarsi obliquely downward, forward and lateralward to the upper surface of the calcaneus; (5) the *ligamentum talocalcaneum interosseum* (O. T. interosseous ligament) (see Figs. 315 and 318) fills up the sinus tarsi and consists of several broad, usually short, bands of fibres which go from the sulcus tali to the sulcus calcanei; in front it is partially covered over and sometimes only indistinctly separable from the ligamentum talocalcaneum laterale. The sinus tarsi contains also masses of fat and in these, near the ligamentum talocalcaneum laterale, there is often a bursa, the *bursa sinus tarsi* (not figured).

On the back of the foot are the following ***ligamenta tarsi dorsalia:*** the *ligamentum talonaviculare [dorsale]* (O. T. superior astragalonavicular ligament) (see also Figs. 315 and 316) extends as a broad ligament from the upper surface of the collum tali to the upper surface of the os naviculare; the *ligamentum bifurcatum* (see also Figs. 315, 318 and 322) has a broad origin near the anterior margin of the dorsal surface of the calcaneus in front of the ligamentum talocalcaneum laterale and divides fork-like into the stronger *pars calcaneonavicularis* (O. T. superior or external calcaneonavicular ligament), reaching wide into the depth, which is attached to the posterior lateral angle of the os naviculare, and into the *pars calcaneocuboidea* (O. T. internal calcaneocuboid ligament) which goes to the upper surface of the os cuboideum; the *ligamentum calcaneocuboideum dorsale* (O. T. external calcaneocuboid ligament) (see also Figs. 315 and 318) runs lateralward from the preceding from the upper surface of the calcaneus to the upper surface of the os cuboideum; the *ligamentum cuboideonaviculare dorsale* (see also Figs. 315 and 318) stretches out transversally between the upper surfaces of the os naviculare and the os cuboideum; the *ligamenta navicularicuneiformia dorsalia* (see also Figs. 315 and 316) are from four to five fibrous bands which extend from the dorsal surface of the os naviculare to the upper surfaces of the three cuneiform bones; the two *ligamenta intercuneiformia dorsalia,* sometimes still further subdivided, pass transversely from the dorsal surface of one cuneiform bone to that of the adjoining bone; the *ligamentum cuneocuboideum dorsale* (see also Fig. 315) is a ligament (frequently divided) extending from the upper surface of the third cuneiform bone to that of the cuboid bone.

The **articulationes tarsometatarseae [Lisfranci]** (O. T. tarsometatarsal articulations) (see also pp. 243 and 245) are strengthened by seven (or more) short *ligamenta tarsometatarsea dorsalia;* these extend from the dorsal surfaces of the ossa cuneiformia and from the os cuboideum straight or obliquely forward to the bases ossium metatarsalium; in this way the second metacarpal bone is connected with all three cuneiform bones.

The **articulationes intermetatarseae** (O. T. articulations of the metatarsal bones with each other) (see also pp. 243 and 245) possess three *ligamenta basium [ossium metatarsalium] dorsalia* which are stretched out transversely between the dorsal surfaces of the proximal ends of the second to the fifth os metatarsale.

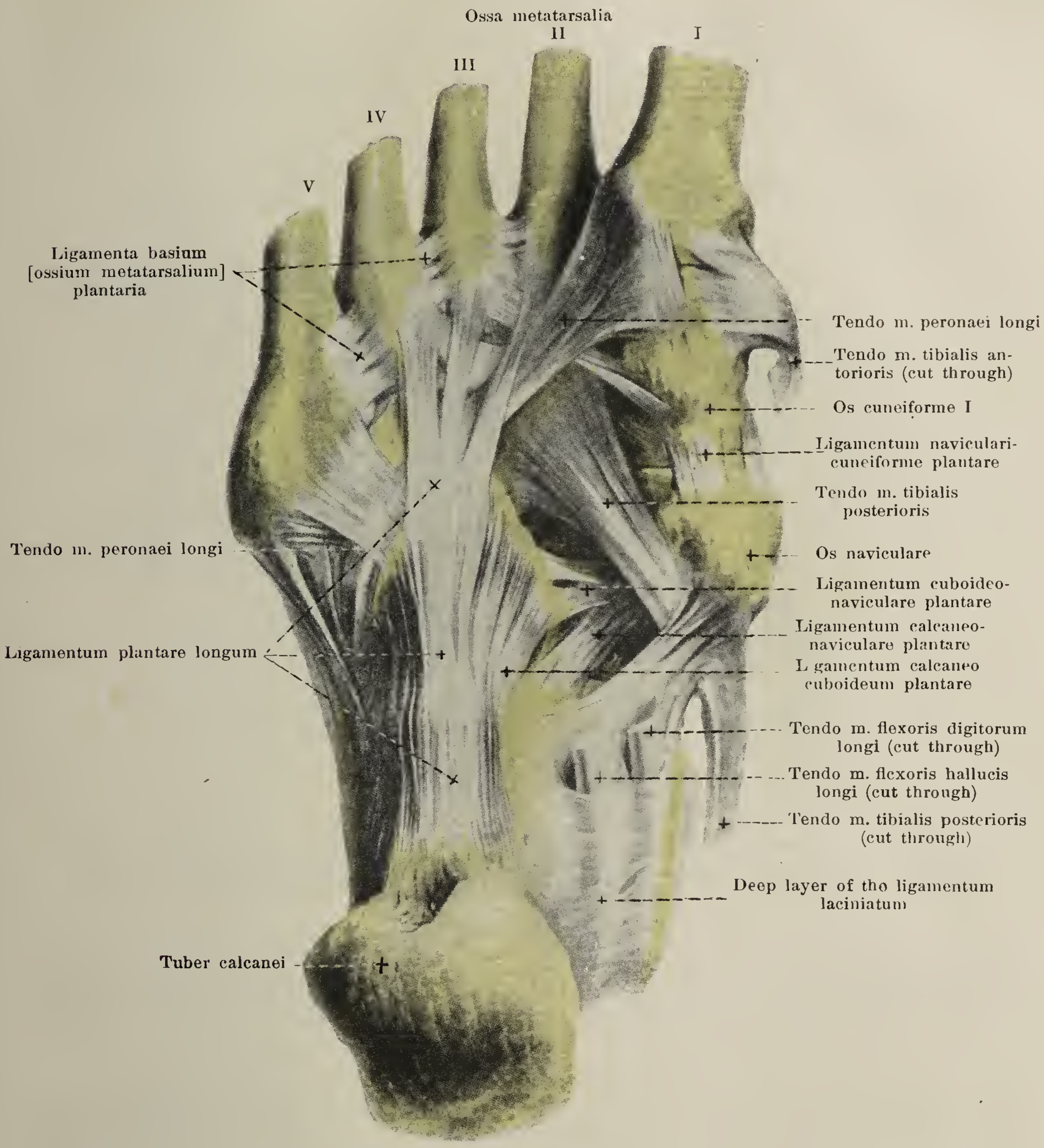

Ligamentum cuboideonaviculare dorsale
Os naviculare
Ligamentum calcaneonaviculare plantare
Fibrocartilago navicularis
Facies articulares anterior et media calcanei
Sustentaculum tali calcanei
Pars calcaneonavicularis
Pars calcaneocuboidea
ligamenti bifurcati
Os cuboideum
Ligamentum calcaneocuboideum dorsale
Ligamentum talocalcaneum laterale
Ligamentum talocalcaneum interosseum
Ligamentum talocalcaneum anterius
cut through close to attachment
Facies articularis posterior calcanei
Calcaneus

318. **Joints of the right foot,** ***articulationes pedis,***
viewed from the back of the foot.

(The talus has been removed as have also the cuneiform bones and the metacarpal bones; the capsulae articulares have been removed except for the strengthening ligaments.)

Articulationes intertarseae (continued).

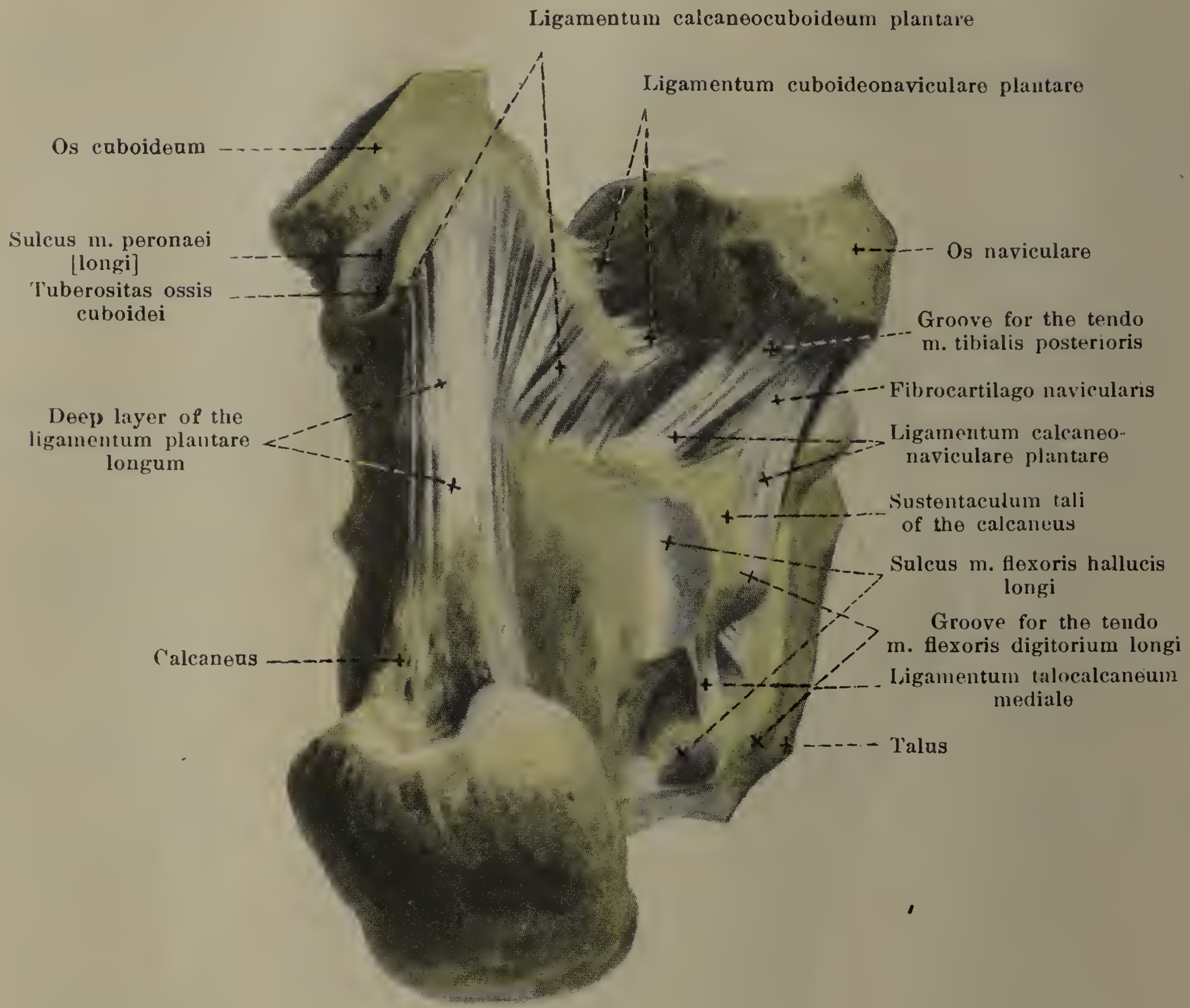
The talus is movably united with the calcaneus and with the os naviculare with constant formation of two separate joint cavities (see also Fig. 322). The posterior joint cavity is situated between the facies articularis calcanea posterior of the talus and the facies articularis posterior of the calcaneus; this union is called the **articulatio talocalcanea;** its *capsula articularis* goes off from the bone usually near the margins of the cartilaginous surfaces; the strengthening ligaments belonging here are the ligamenta talocalcanea posterius, anterius et mediale (see p. 239); the ligamentum calcaneotibiale and the ligamentum calcaneofibulare are likewise entitled to the same designation. The anterior joint cavity lies between the facies articulares calcaneae media et anterior of the talus and the facies articulares media et anterior of the calcaneus as well as between the facies articularis navicularis of the talus and the proximal joint surface of the os naviculare; besides, the joint concavity is made still more complete for the caput tali by means of the ligamentum calcaneonaviculare plantare (see p. 242) and the fibrocartilago navicularis enclosed in this, as well as by the pars calcaneonavicularis ligamenti bifurcati (see p. 239); this anterior joint union is known as the **articulatio talocalcaneonavicularis;** its most anterior portion is also known separately as the *articulatio talonavicularis;* its *capsula articularis* leaves the bones for the most part near the margins of the cartilaginous surfaces; lying close upon the capsule, as a strengthening ligament of the same, is the ligamentum talonaviculare [dorsale] (see p. 239) while the ligamenta talocalcanea laterale et interosseum (see p. 239) are separated from it by masses of fat; in addition, the ligamentum calcaneonaviculare plantare and the pars calcaneonavicularis ligamenti bifurcati, and (indirectly) also the ligamentum tibionaviculare, have to be designated as strengthening ligaments.


Ossa metatarsalia
II
I
III
IV
V
Ligamenta basium [ossium metatarsalium] plantaria
Tendo m. peronaei longi
Tendo m. tibialis anterioris (cut through)
Os cuneiforme I
Ligamentum naviculari-cuneiforme plantare
Tendo m. tibialis posterioris
Tendo m. peronaei longi
Os naviculare
Ligamentum cuboideonaviculare plantare
Ligamentum calcaneonaviculare plantare
Ligamentum plantare longum
Ligamentum calcaneocuboideum plantare
Tendo m. flexoris digitorum longi (cut through)
Tendo m. flexoris hallucis longi (cut through)
Tendo m. tibialis posterioris (cut through)
Deep layer of the ligamentum laciniatum
Tuber calcanei

319. Joints of the right foot, ***articulationes pedis,***
viewed from the sole of the foot.

(The ossa metatarsalia have been sawed through in the middle, the capsulae articulares with the exception of the strengthening ligaments have been removed.)

Articulationes intertarseae (continued). Their capsules are strengthened in the sole of the foot by the ***ligamenta tarsi plantaria.*** The strongest of them is the *ligamentum plantare longum* (O. T. long calcaneocuboid or long plantar ligament) (see also Fig. 320). It is very broad and powerful, arises from the lower surface of the calcaneus in front of the tuber calcanei and extends with its main to the tuberositas ossis cuboidei. As a continuation of its most superficial bundles it sends thin diverging fibrous strips to the proximal ends of the ossa metatarsalia II—V which bridge over the groove for the tendon of the m. peronaeus longus.


Ligamentum calcaneocuboideum plantare
Ligamentum cuboideonaviculare plantare
Os cuboideum
Sulcus m. peronaei [longi]
Tuberositas ossis cuboidei
Deep layer of the ligamentum plantare longum
Calcaneus
Os naviculare
Groove for the tendo m. tibialis posterioris
Fibrocartilago navicularis
Ligamentum calcaneonaviculare plantare
Sustentaculum tali of the calcaneus
Sulcus m. flexoris hallucis longi
Groove for the tendo m. flexoris digitorium longi
Ligamentum talocalcaneum mediale
Talus

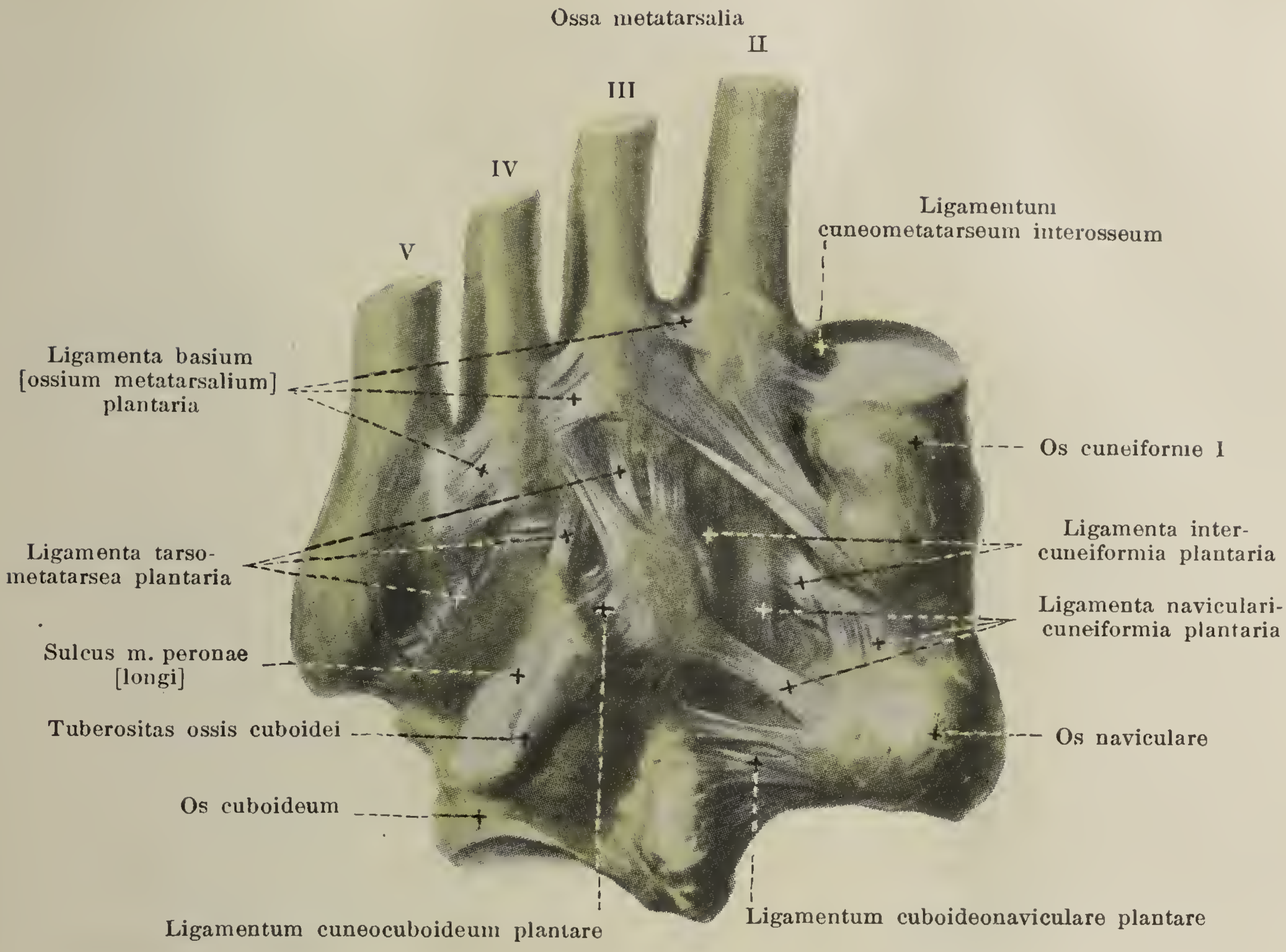
320. Joints of the right foot, *articulationes pedis,*

viewed from the sole of the foot.

(The cuneiform bones and the metatarsal bones have been removed; the superficial layer and the most anterior processes of the ligamentum plantare longum have been cut off, the capsulae articulares except the strengthening ligaments have been removed.)

Articulationes intertarseae (continued). ***Ligamenta tarsi plantaria*** (continued). The *ligamentum calcaneocuboideum plantare* (O. T. short calcaneocuboid or short plantar ligament) (see also Fig. 319) is a broad band of short fibres which go from the anterior end of the lower surface of the calcaneus to the lower surface of the os cuboideum; they are partially covered by the ligamentum plantare longum which lies more superficially and is more or less intimately fused with it.

The *ligamentum calcaneonaviculare plantare* (O. T. inferior calcaneonavicular ligament) (see also Figs. 316, 318 and 319) arises as a thick, broad mass of fibres from the anterior and medial margin of the sustentaculum tali of the calcaneus and is fastened to the posterior end of the inferior and medial surface of the os naviculare. The ligament, the bands of which extend essentially from behind forward and connect dorsalward with the ligamentum tibionaviculare, forms a trough which is concave upward and lateralward (see Fig. 318); its upper concave surface is lined by synovial membrane, belongs to the articulatio talocalcaneonavicularis and forms a part of the socket for the caput tali (see p. 240). At the junction of the inferior with the medial surface a slightly curved fibro-cartilaginous disc, *fibrocartilago navicularis*, is enclosed (see Fig. 318). The medial, inferior surface of the ligament is hollowed out to form a shallow groove and serves for the reception of the tendon of the m. tibialis posterior.


Ossa metatarsalia
II
III
IV
V
Ligamentum cuneometatarseum interosseum
Ligamenta basium [ossium metatarsalium] plantaria
Os cuneiforme I
Ligamenta tarsometatarsea plantaria
Ligamenta intercuneiformia plantaria
Ligamenta navicularicuneiformia plantaria
Sulcus m. peronae [longi]
Tuberositas ossis cuboidei
Os naviculare
Os cuboideum
Ligamentum cuneocuboideum plantare
Ligamentum cuboideonaviculare plantare

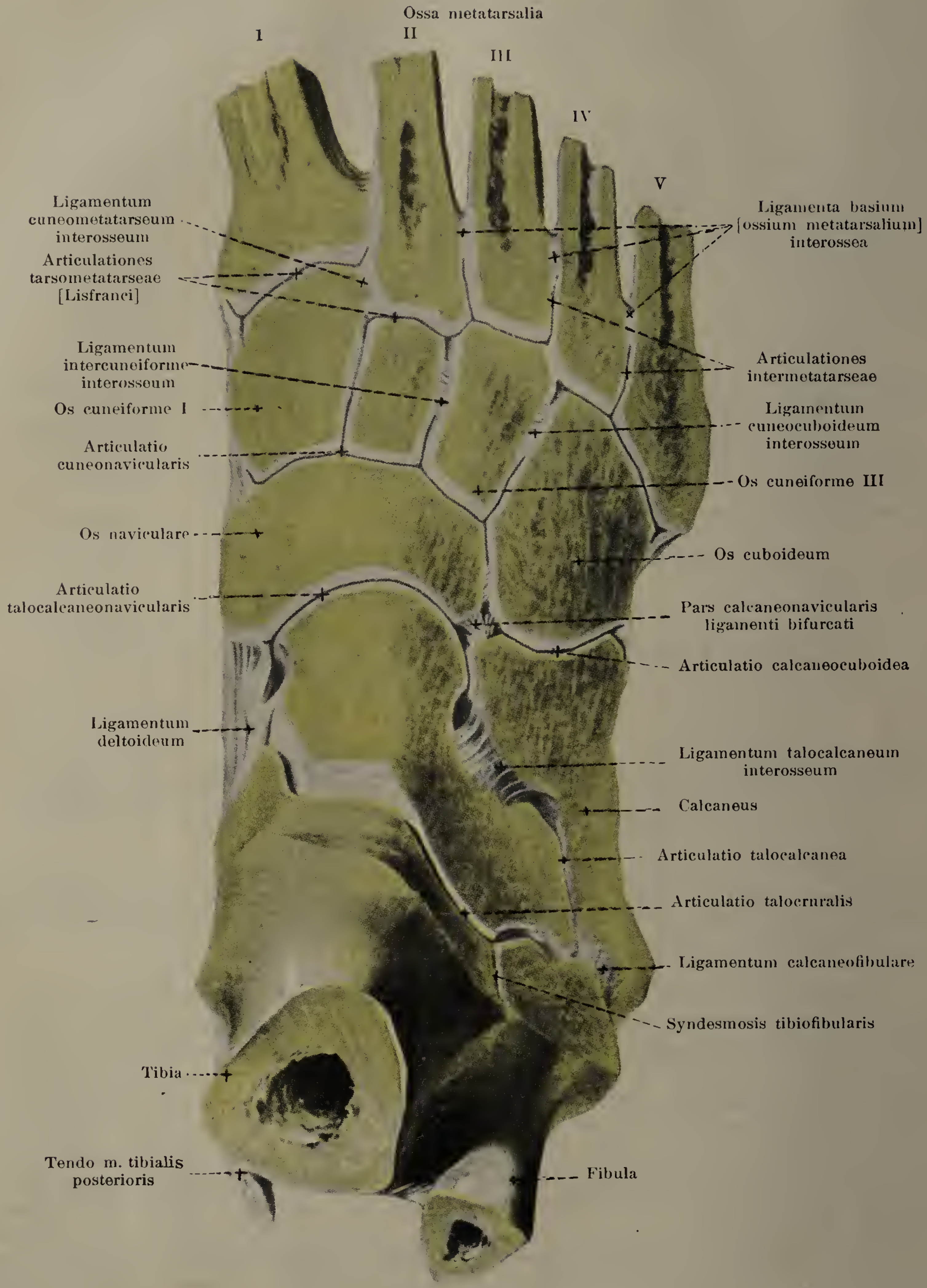
321. Joints of the right foot, *articulationes pedis,*
viewed from the sole of the foot.

(The calcaneus and talus have been removed at the so-called articulatio tarsi transversa [Choparti]. The os metatarsale I has been completely excised, the ossa metatarsalia II—V have been sawed through in the middle. The capsulae articulares, with the exception of the strengthening ligaments, have been removed.)

Articulationes intertarseae (continued). ***Ligamenta tarsi plantaria*** (continued). The *ligamentum cuboideonaviculare plantare* (see also Figs. 319 and 320) is stretched out between the plantar surface of the os cuboideum and the os naviculare. The *ligamenta navicularicuneiformia plantaria* (see also Figs. 316 and 319) are three short bands of fibres passing directly or obliquely forward, which extend from the plantar surface of the os naviculare to the plantar surfaces of the ossa cuneiformia. The two *ligamenta intercuneiformia plantaria* run as short fibre bundles transversely between the plantar surfaces of the ossa cuneiformia. The *ligamentum cuneocuboideum plantare* goes as a broad band from the under surface of the os cuneiforme III obliquely lateralward and backward to the plantar surface of the os cuboideum.

The **articulationes tarsometatarseae [Lisfranci]** (see also pp. 239 and 245) have plantarward a large number of strengthening ligaments,*ligamenta tarsometatarsea plantaria,* which, partly shorter, partly longer, run on the plantar surface from the ossa cuneiformia and from the os cuboideum to the bases ossium metatarsalium.

The **articulationes intermetatarseae** (see also pp. 239 and 245) are strengthened plantarward by three *ligamenta basium [ossium metatarsalium] plantaria* (see also Fig. 319) which spread out on the plantar surface transversely between the proximal ends of the second to the fifth metatarsal bone.


Ossa metatarsalia
I
II
III
IV
V
Ligamentum cuneometatarseum interosseum
Articulationes tarsometatarseae [Lisfranci]
Ligamentum intercuneiforme interosseum
Os cuneiforme I
Articulatio cuneonavicularis
Os naviculare
Articulatio talocalcaneonavicularis
Ligamentum deltoideum
Tibia
Tendo m. tibialis posterioris
Ligamenta basium [ossium metatarsalium] interossea
Articulationes intermetatarseae
Ligamentum cuneocuboideum interosseum
Os cuneiforme III
Os cuboideum
Pars calcaneonavicularis ligamenti bifurcati
Articulatio calcaneocuboidea
Ligamentum talocalcaneum interosseum
Calcaneus
Articulatio talocalcanea
Articulatio talocruralis
Ligamentum calcaneofibulare
Syndesmosis tibiofibularis
Fibula

322. Joints of the right foot, ***articulationes pedis,***

from the back of the foot.

(The surface of a frozen foot has been filed off until the joint cavities have been opened.)

Articulationes pedis.

Articulationes intertarseae. The joint slits of the *articulatio talocalcanea* and of the *articulatio talocalcaneonavicularis* (see p. 240) are completely closed off not only from one another, but also from the neighboring joint slits; the *articulatio talonavicularis* is only a part of the articulatio talocalcaneonavicularis (see p. 240).

In the formation of the *articulatio calcaneocuboidea* the facies articularis cuboidea of the calcaneus moves upon the proximal joint surface of the os cuboideum; its *capsula articularis* arises close to the margins of the cartilaginous surfaces; the joint cavity is not connected with adjoining ones. The articulatio calcaneocuboidea and the articulatio talonavicularis are also designated in common by the name *articulatio tarsi transversa [Choparti]*; their joint cavities form together a surface interrupted by the ligamentum bifurcatum the cross-section of which is curved ∽-like.

The *articulatio cuneonavicularis* is the joint between the distal surface of the os naviculare and the proximal surfaces of the ossa cuneiformia; the *capsula articularis* surrounds these joint surfaces, but in addition also those by which the ossa cuneiformia articulate with one another and those by which the os cuboideum glides upon the os cuneiforme III and usually also on the os naviculare; the capsule is attached everywhere close to the margin of the cartilaginous surfaces. The joint cavity is connected as a rule, between the first and second cuneiform bones with the cavity of the articulatio tarsometatarsea of the os metatarsale II (and through this also with that of the os metatarsale III). Short ligaments extend in the depth between the cuneiform bones and also between the third cuneiform bone and the cuboid bone: two *ligamenta intercuneiformia interossea* and one *ligamentum cuneocuboideum interosseum* (see also Fig. 322).

In the formation of the ***articulationes tarsometatarseae [Lisfranci]*** the proximal joint surfaces of the bases ossium metatarsalium are in contact with the distal joint surfaces of the ossa cuneiformia and of the os cuboideum. The places of junction form, in general, a surface convex from the medial toward the lateral side, which is interrupted at the os cuneiforme II, in that the os metatarsale II reaches further proximalward than the others; there is besides a less abrupt break in surface between the os cuneiforme III and the os cuboideum. Usually three separate joint capsules are present: the first between the os cuneiforme I and os metatarsale I (sometimes also os metatarsale II), the second between the ossa cuneiformia I, II et III and the ossa metatarsalia II et III, the third between the os cuneiforme III, the os cuboideum and the ossa metatarsalia IV et V; the second joint cavity is usually connected with that of the articulatio cuneonavicularis. Their capsules arise everywhere from the bones close to the margin of the cartilaginous surfaces. From the lateral surfaces of the ossa cuneiformia and the os cuboideum fibrous strands of variable development run in the depth to the neighboring lateral surfaces of the bases ossium metatarsalium II—IV; they are called *ligamenta cuneometatarsea interossea* (see also Fig. 321) and *ligamentum cuboideometatarseum interosseum*, respectively (not figured).

The ***articulationes intermetatarseae*** are formed in that the proximal ends of the (first) second to the fifth os metatarsale are in contact with the cartilaginous surfaces opposed to one another. The joint slits communicate with those of the corresponding articulatio tarsometatarsea; the *capsulae articulares* arise from the bones close to the margin of the cartilaginous surfaces. Three *ligamenta basium [ossium metatarsalium] interossea* extend, in the depth, between the neighboring surfaces of the bases ossium metatarsalium.

The ***articulationes metatarsophalangeae*** and the ***articulationes digitorum pedis*** (O. T. articulations of the phalanges) present as regards their capsules and ligaments, essentially the same relations as do the corresponding joints in the hand (see pp. 208 and 209). The sole difference is that the *ligamentum capitulorum [ossium metatarsalium] transversum* extends from the first to the fifth os metatarsale.

Appendix

Roentgenograms.

Preliminary Remarks upon their interpretation.

The designations ventro-dorsal, dorso-volar, occipito-frontal, etc., indicate the course of the roentgen rays during the preparation of the photographs. The term ventro-dorsal, for example, means that, on taking the picture, the roentgen tube was placed ventral from the body or from the part of the body concerned, the photographic film dorsal from it, so that the roentgen rays passed through the body, or the part of the body concerned, in a direction from the ventral toward the dorsal surface. If, on considering an x-ray photograph, we think of the eye of the observer as situated at the site of the roentgen tube, the following facts must be borne in mind:

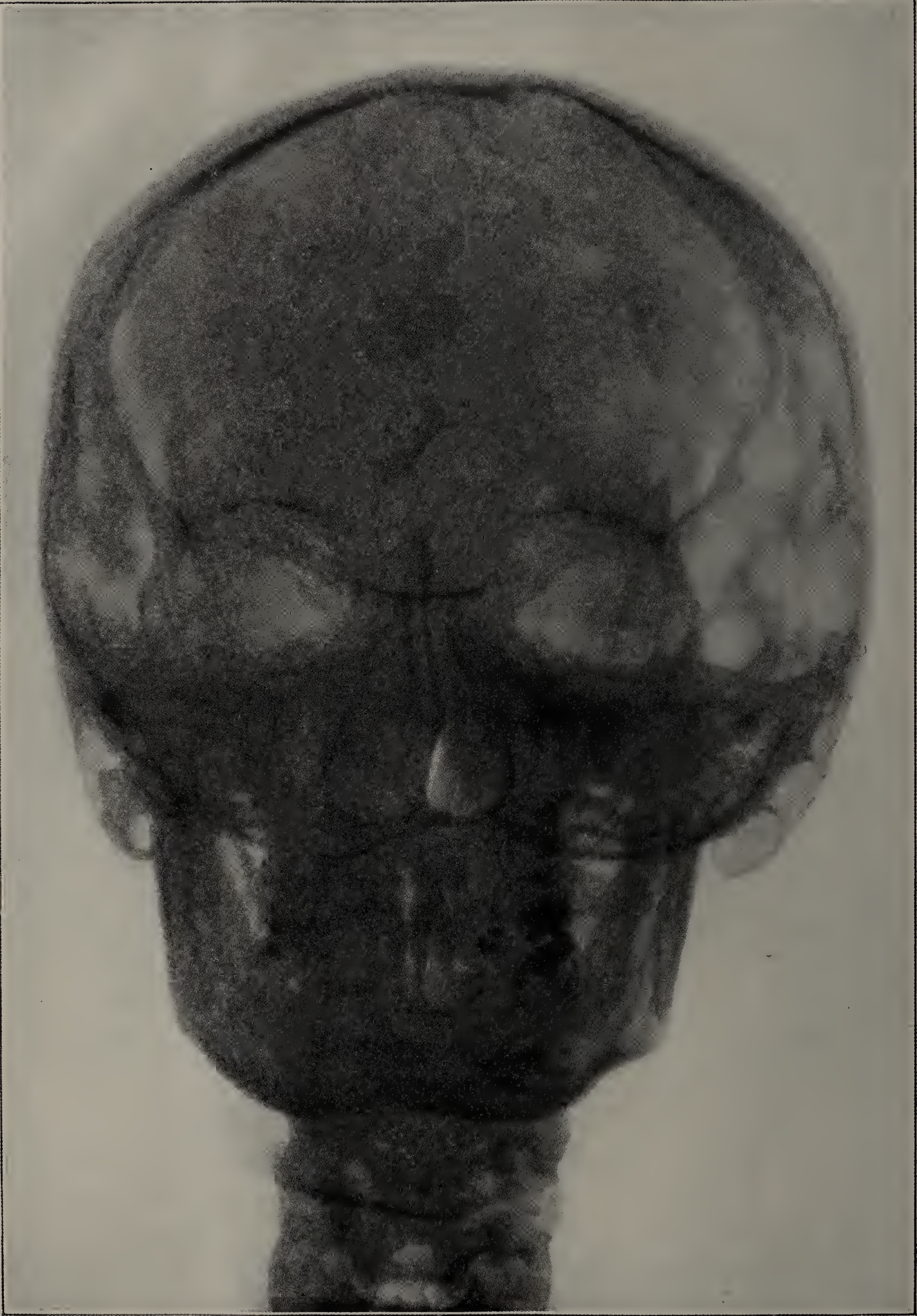
On ordinary central projection, the parts of a bodily object that lie nearer to the observer appear somewhat larger and their contours look more sharp than those that lie further away. The picture produced by the roentgen rays follows this law only in this far, namely that in it also the parts lying nearer the tube are larger in the picture than those that are further away; but it deviates from that law in that the contours of the parts that lie nearer the tube appear to be less sharp than those that are farther removed from the tube, that is to say, than those that lie nearer to the photographic film. Thus the perspective size-relations are precisely the same in the two processes, whereas the sharpness of the contours is in direct opposition.

In the preparation of the explanatory tracings, in order to make the pictures like those of ordinary central projection and accordingly more easily understandable for the non-expert—in conscious contrast to the reproduction in the x-ray pictures—, the contours of the parts lying nearer the observer (and the roentgen tube) have been drawn more heavily, and vice versa. Accordingly, the differences in the heaviness of the lines have, in general, a relative value for the spot concerned and its immediate neighborhood only but not for the whole picture; on comparison of different pictures, they do not permit conclusions to be drawn regarding the absolute depth relations.

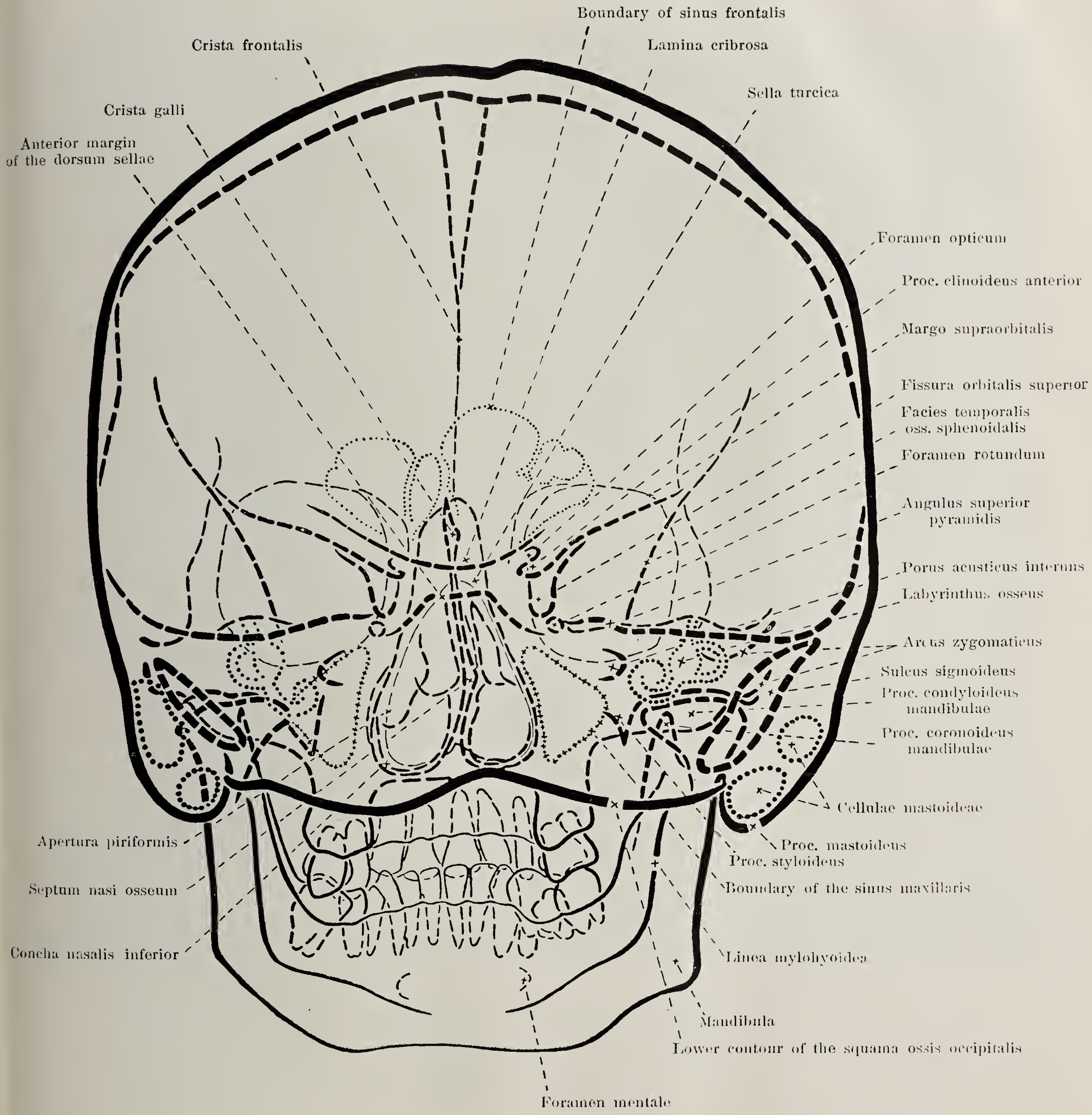
Contours, which on ordinary observation of an organ would be covered by parts of the same organ or by other organs, I have represented by interrupted lines. A different kind of line has been used for different organs, for example, for the odd vertebrae —·—·—·, for the even vertebrae — — — — etc.

I have emphasized especially the intersection of contours, the more distant contour being always designated as such by interruptions.

When two contours coincide I have, when necessary for clearness, used the method of map makers, that is to say, I have drawn the contours along-side of one another.



323a. Skull, occipitofrontal.
Size, 3 : 5.

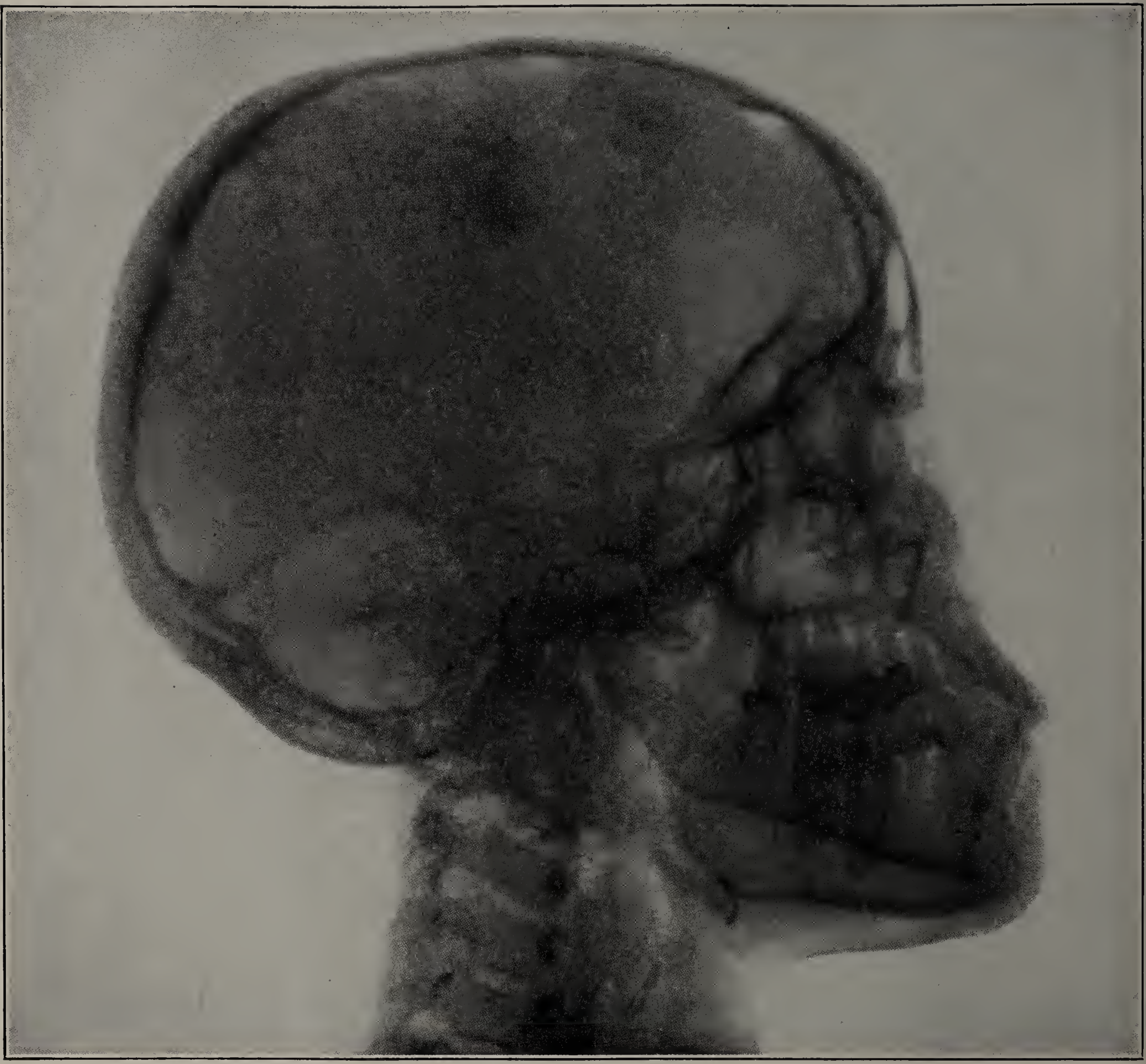


323aa. Skull, occipitofrontal.

Size, 3 : 5.

Tracing for figure IX.

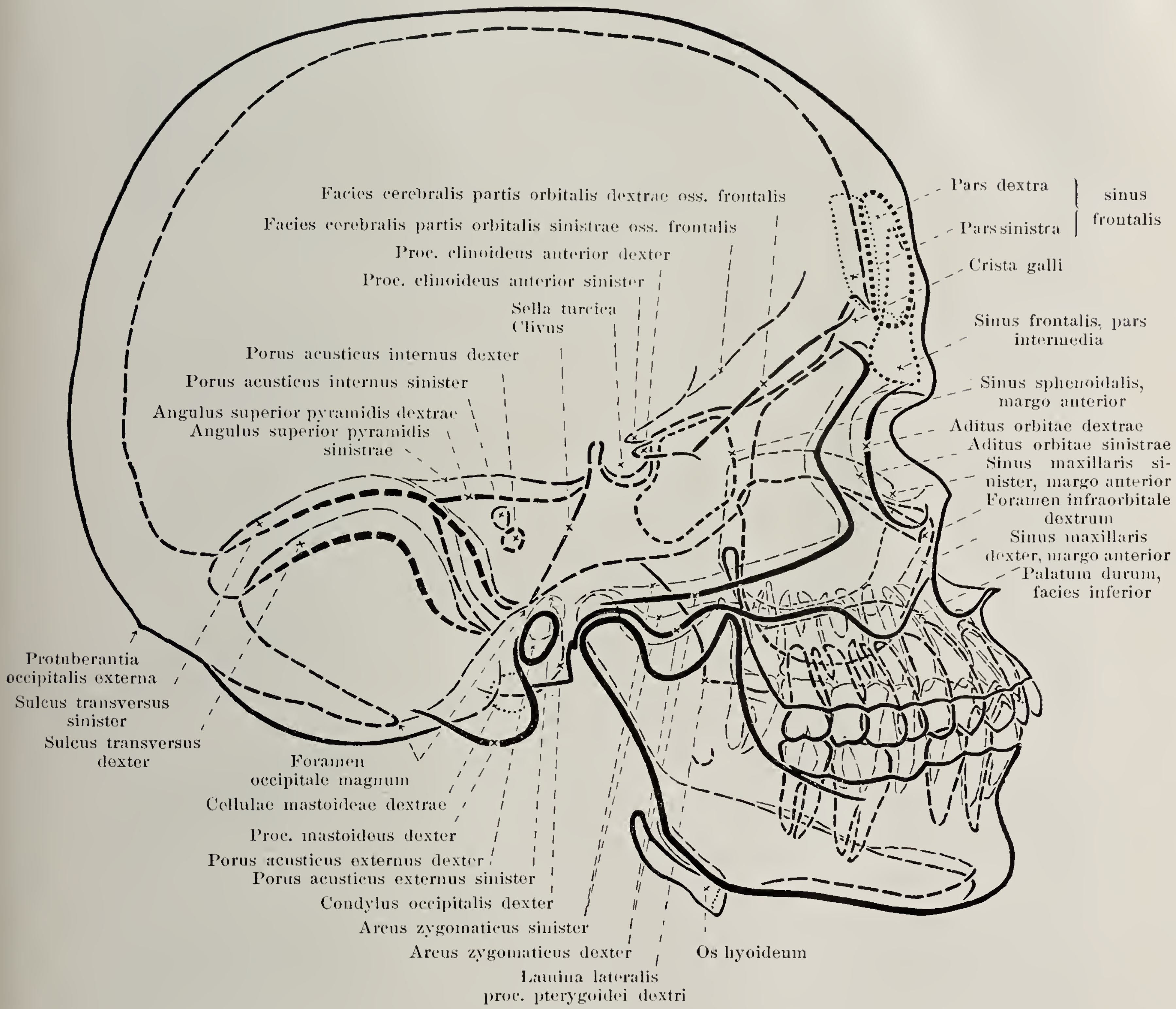
The vertebrae have not been outlined.



323b. Skull, dextrosinistral.

Size, 1 : 2.

For interpretation, see figure 324a.

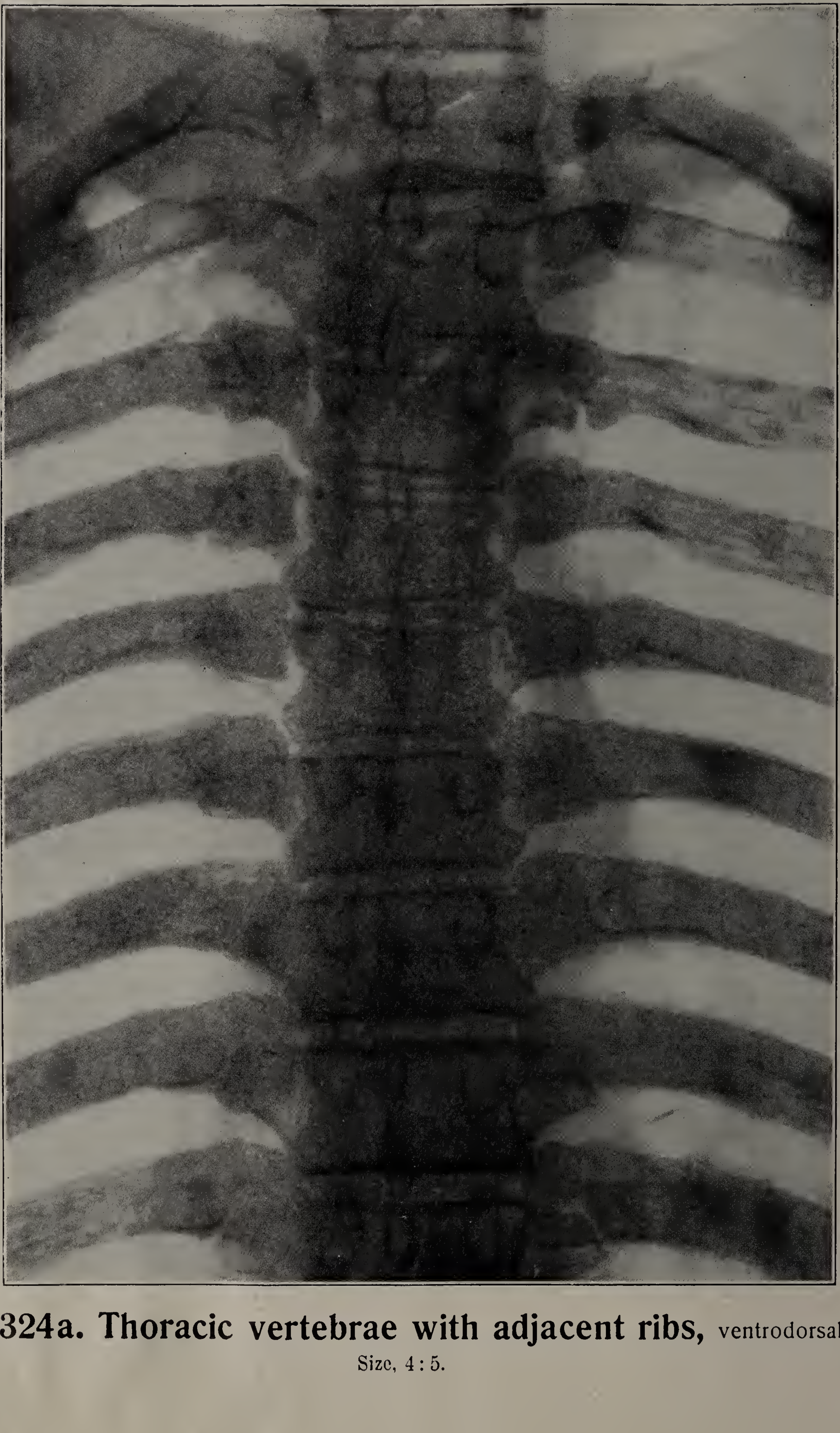

Facies cerebralis partis orbitalis dextrae oss. frontalis
Facies cerebralis partis orbitalis sinistrae oss. frontalis
Proc. clinoideus anterior dexter
Proc. clinoideus anterior sinister
Sella turcica
Clivus
Porus acusticus internus dexter
Porus acusticus internus sinister
Angulus superior pyramidis dextrae
Angulus superior pyramidis sinistrae
Pars dextra
Pars sinistra
sinus frontalis
Crista galli
Sinus frontalis, pars intermedia
Sinus sphenoidalis, margo anterior
Aditus orbitae dextrae
Aditus orbitae sinistrae
Sinus maxillaris sinister, margo anterior
Foramen infraorbitale dextrum
Sinus maxillaris dexter, margo anterior
Palatum durum, facies inferior
Protuberantia occipitalis externa
Sulcus transversus sinister
Sulcus transversus dexter
Foramen occipitale magnum
Cellulae mastoideae dextrae
Proc. mastoideus dexter
Porus acusticus externus dexter
Porus acusticus externus sinister
Condylus occipitalis dexter
Arcus zygomaticus sinister
Arcus zygomaticus dexter
Lamina lateralis proc. pterygoidei dextri
Os hyoideum

323bb. Skull, dextrosinistral.

Axis of x-rays entering a little above the porus acusticus externus dexter. Size, 1 : 2.

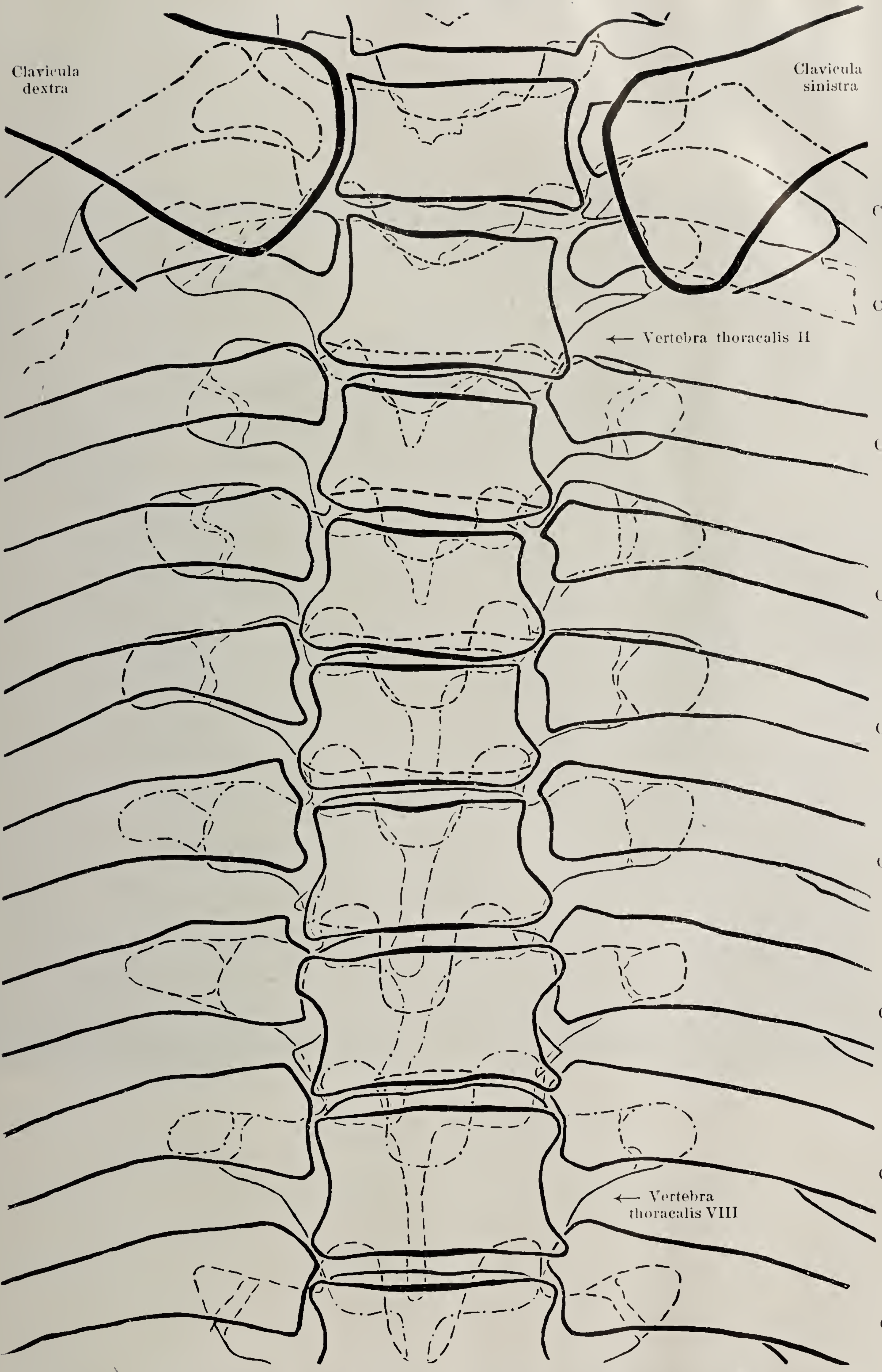
Tracing for figure 323b.

The vertebrae have not been outlined.



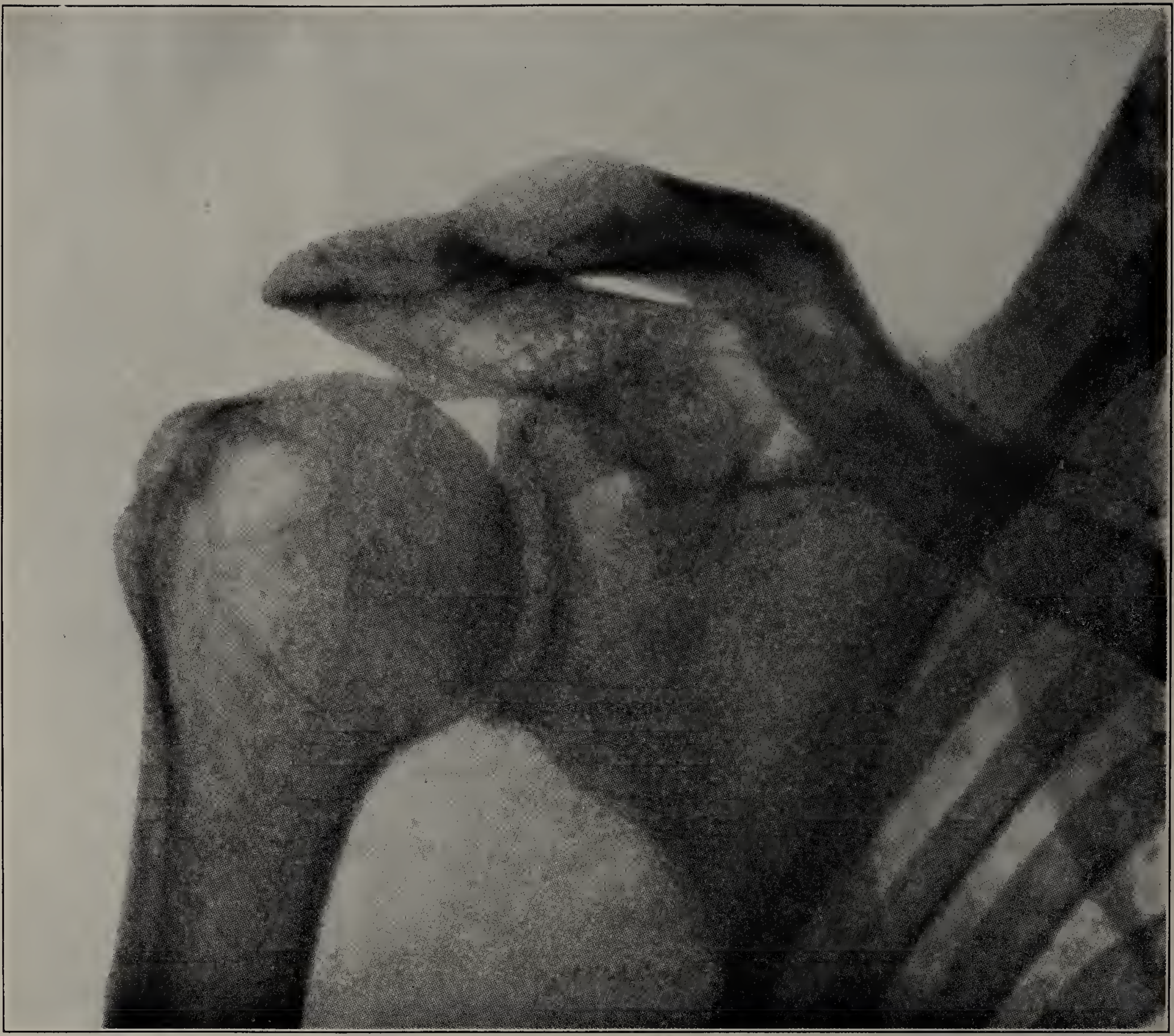
324a. Thoracic vertebrae with adjacent ribs, ventrodorsal.

Size, 4 : 5.



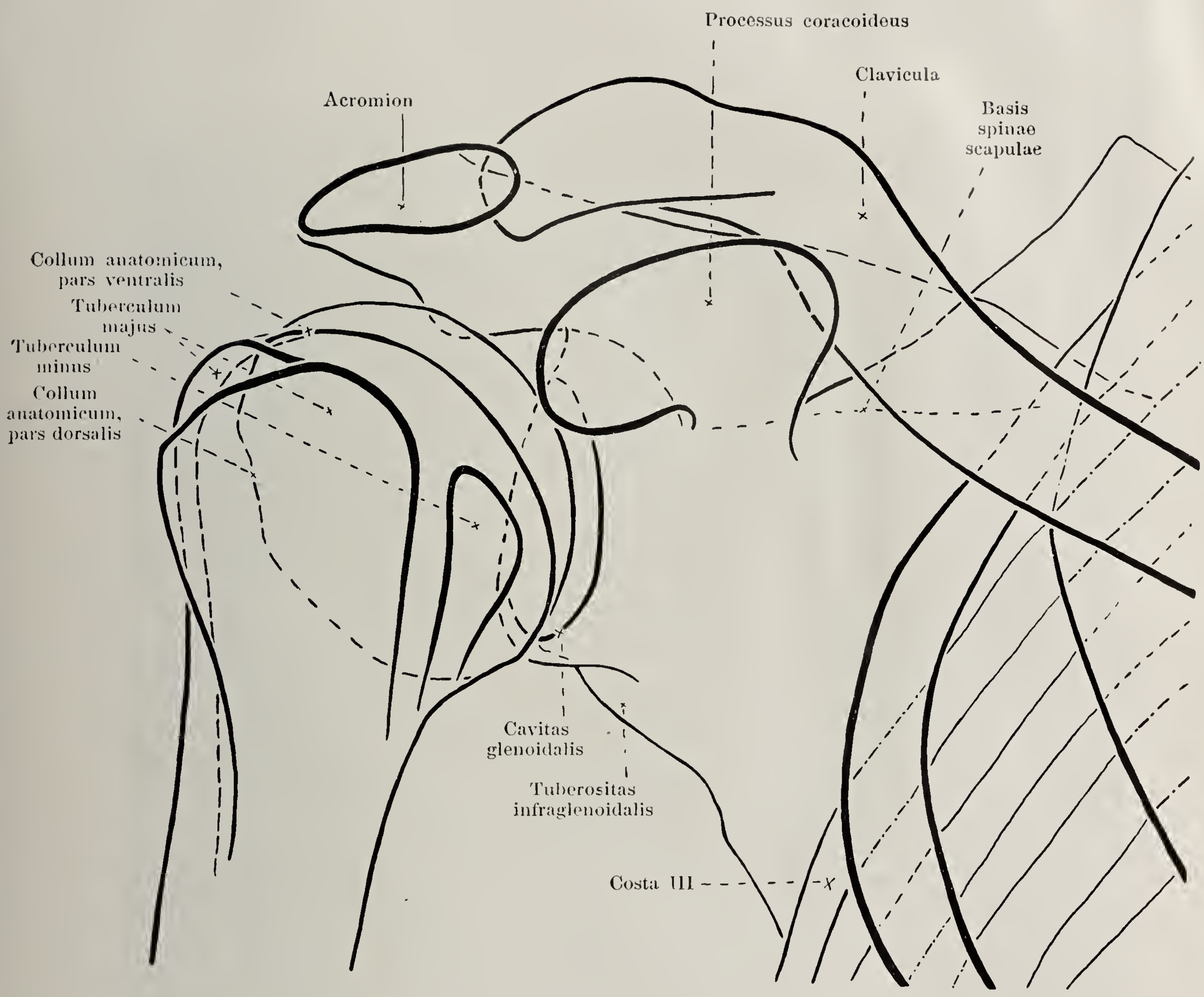
324aa. Thoracic vertebrae with adjacent ribs, ventrodorsal.

Size, 4 : 5. Tracing for figure 324a.



325a. Right shoulder.

Arm rolled medialward; ventrodorsal.
Axis of x-rays entering obliquely from in front and above.
Size, 4 : 5.



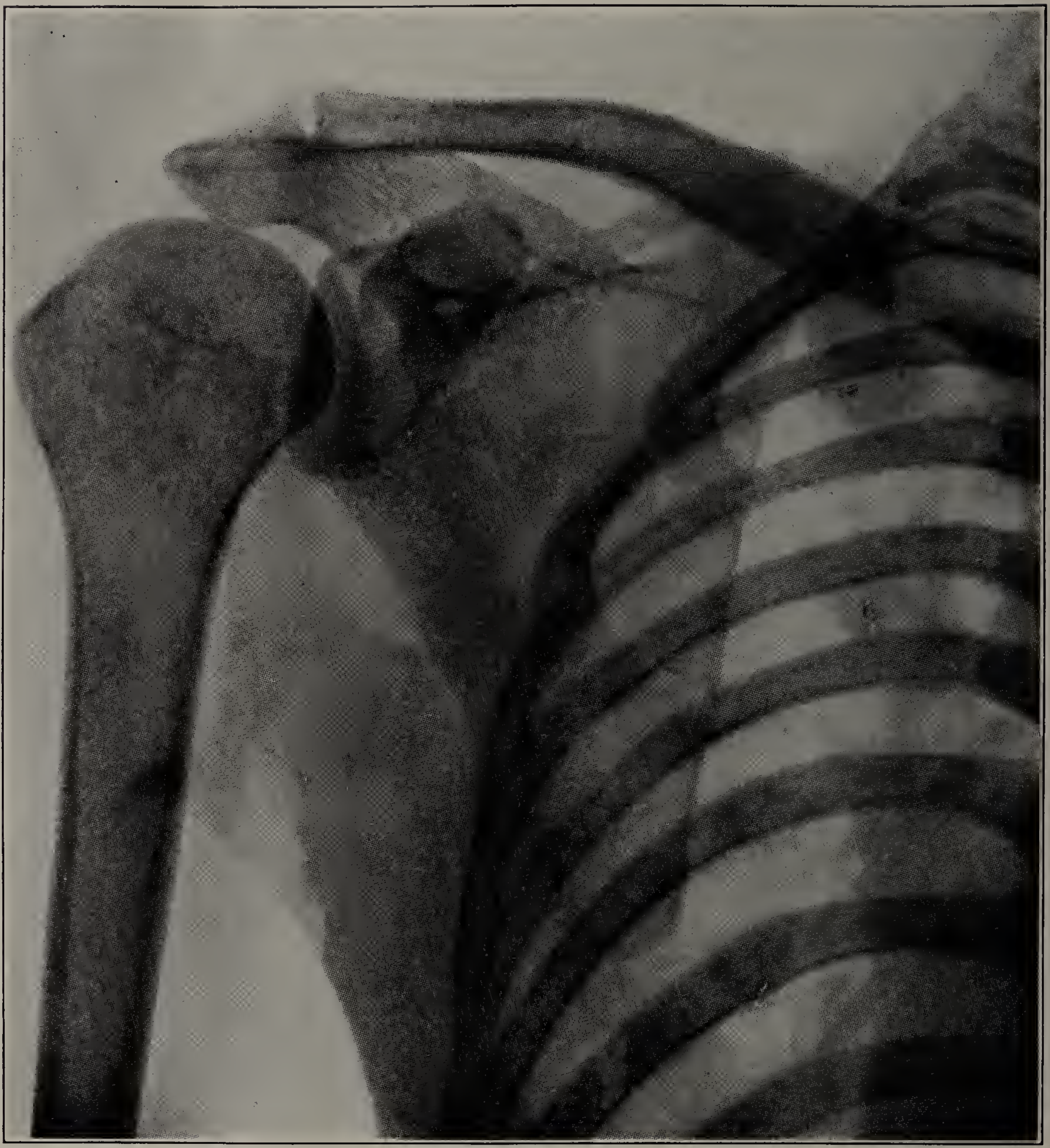
325aa. Right shoulder.

Arm rolled medialward; ventrodorsal.

Axis of x-rays entering obliquely from in front and above.

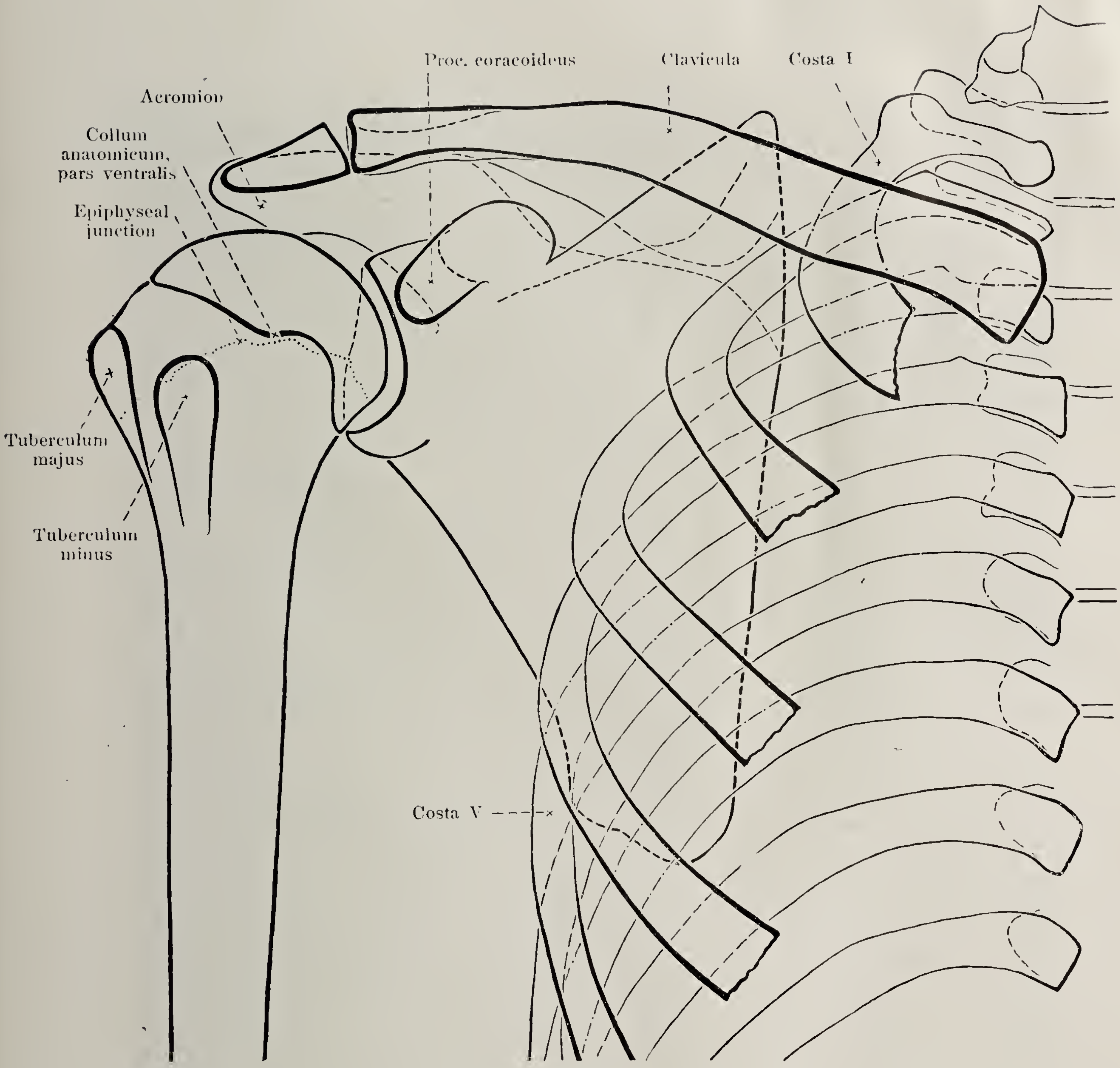
Size, 4 : 5.

Tracing for figure 325a.



325b. Right shoulder.

Arm abducted, vola of the supinated hand directed ventralward; ventrodorsal.
Size, 1 : 2.
Figures 325b–325cc were made from the same person.



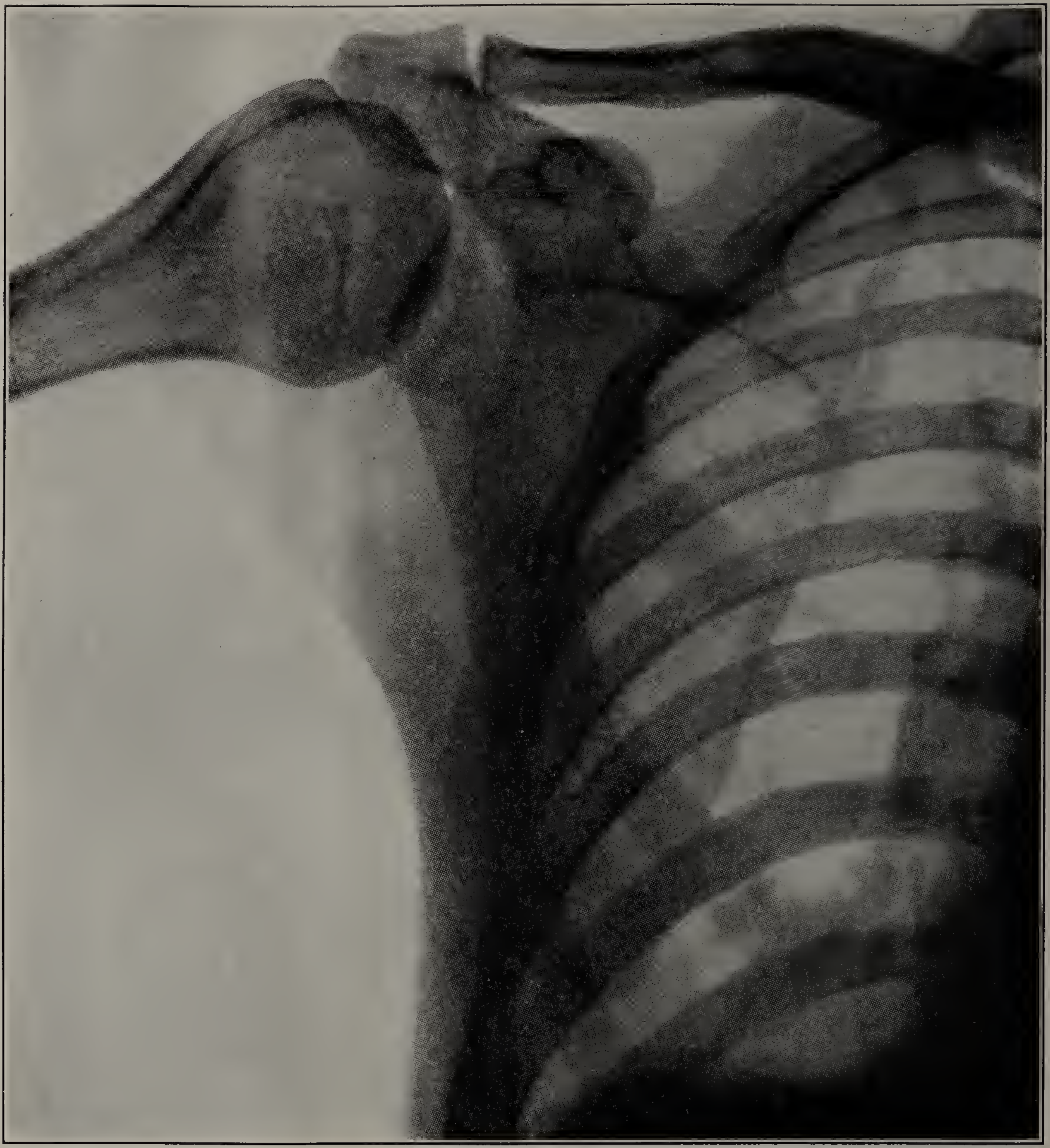
325 bb. Right shoulder.

Arm abducted, vola of the supinated hand directed ventralward; ventrodorsal.

Size, 1 : 2.

Tracing for figure 325 b.

Figures 325 b—325 cc were made from the same person.

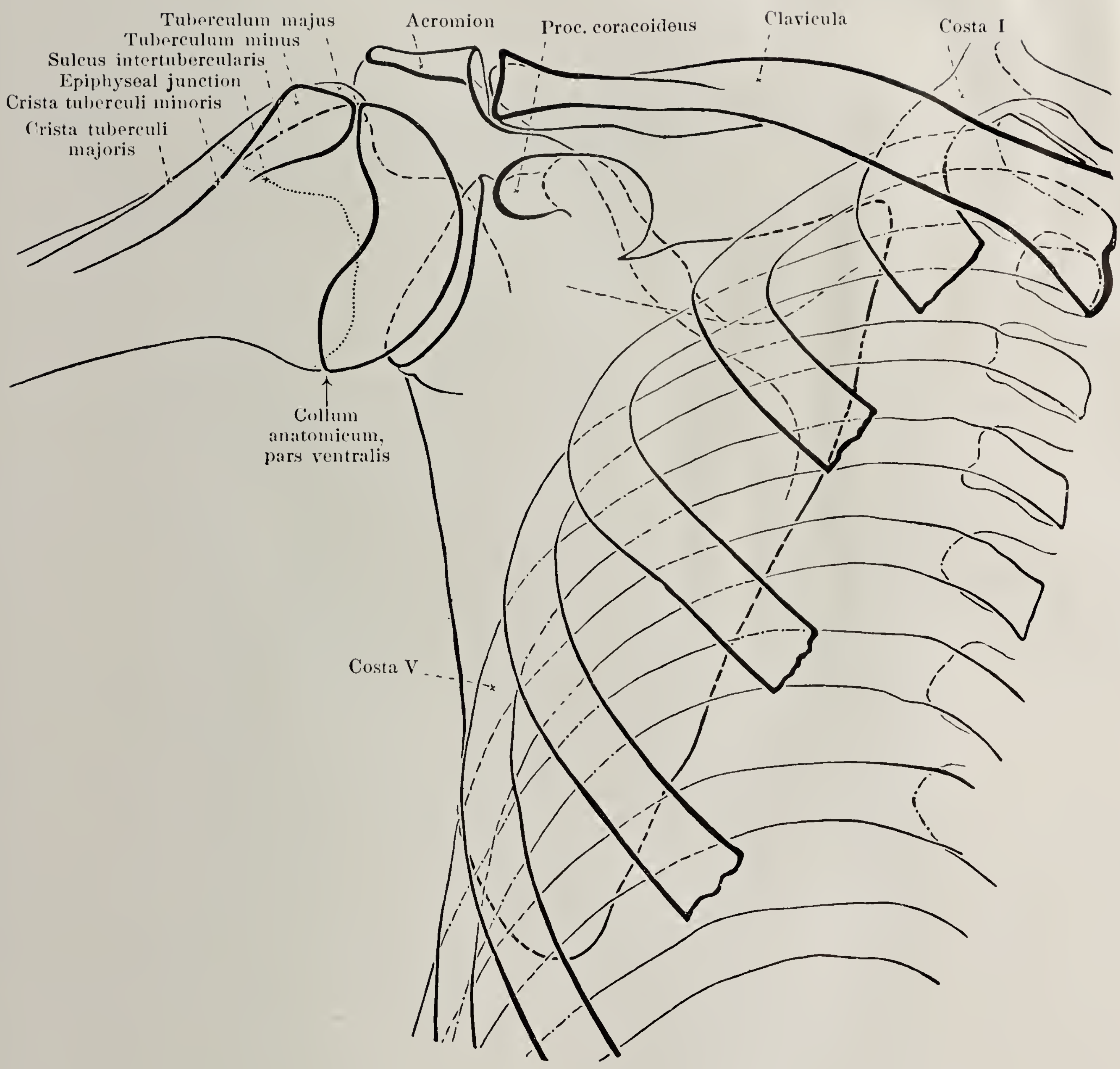


325c. Right shoulder.

Arm abducted (by almost 90°), vola of the supinated hand directed upward; ventrodorsal.

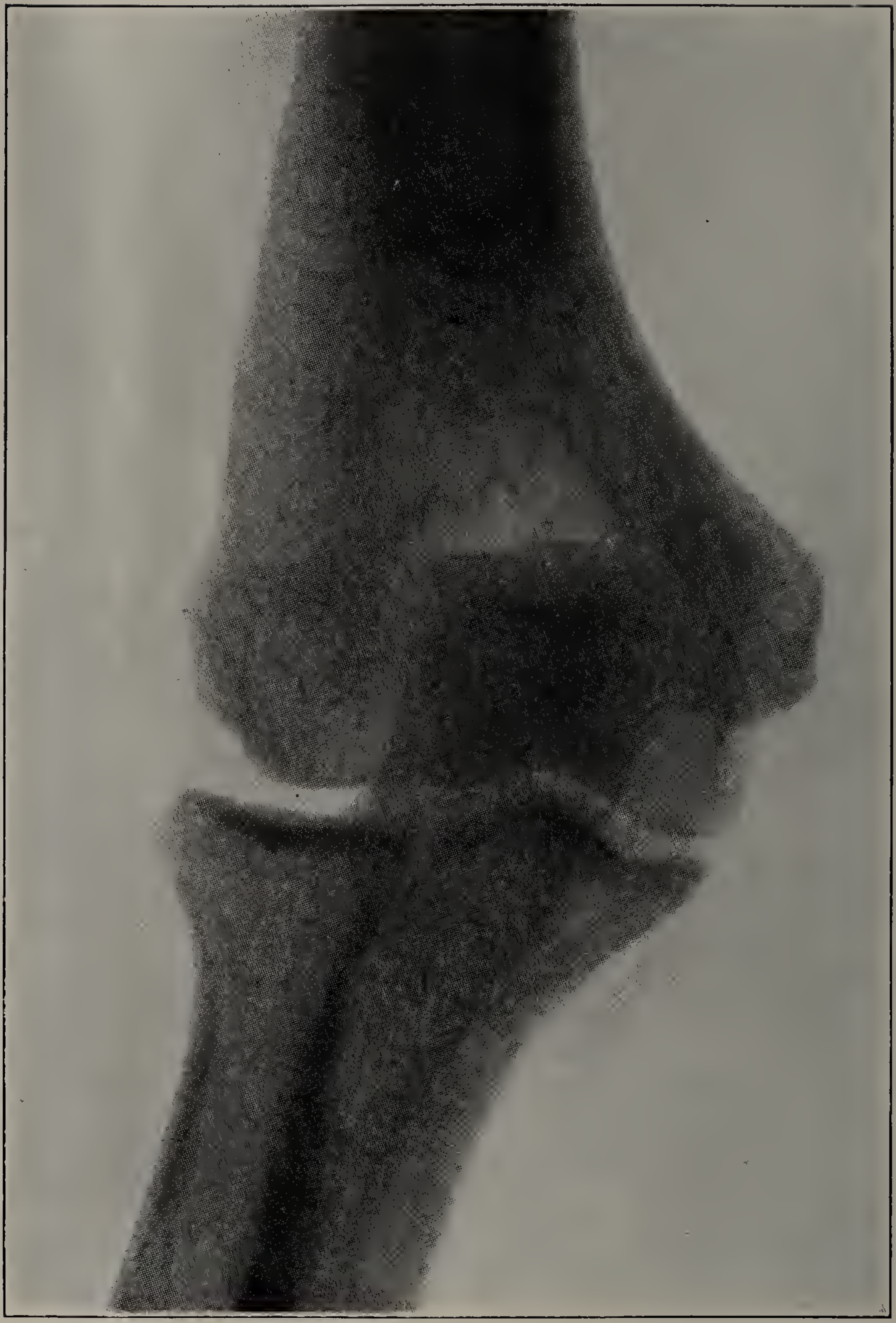
Size, 1 : 2.

Figures 325b—325cc were made from the same person.



325cc. Right shoulder.

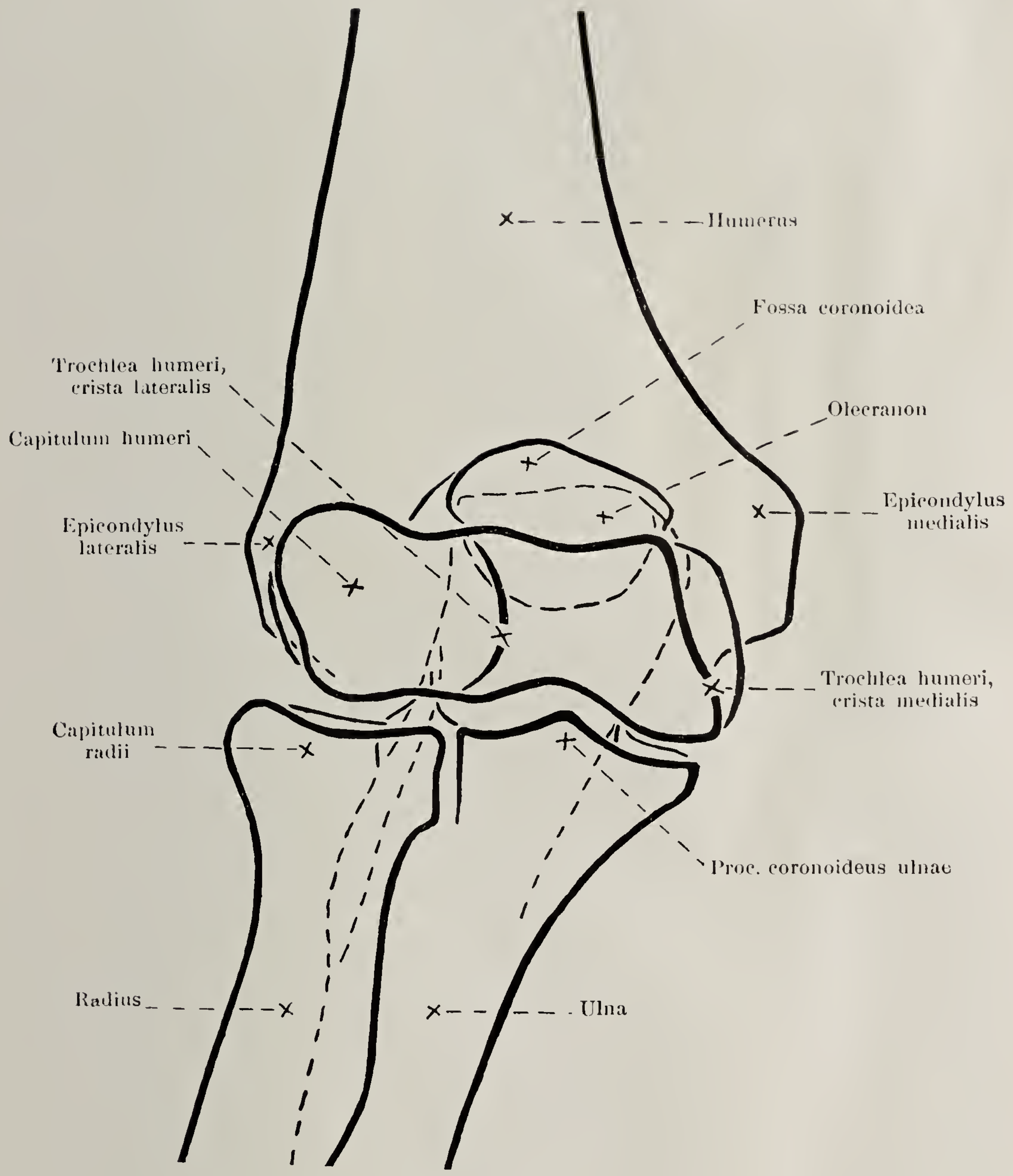
Arm abducted (by almost 90°),
vola of the supinated hand directed upward; ventrodorsal
Size, 1 : 2.
Tracing for figure 325c.
Figures 325b—325cc were made from the same person.



326a. Right elbow joint.

Extended, hand supinated; volodorsal.

Size, 1 : 1.

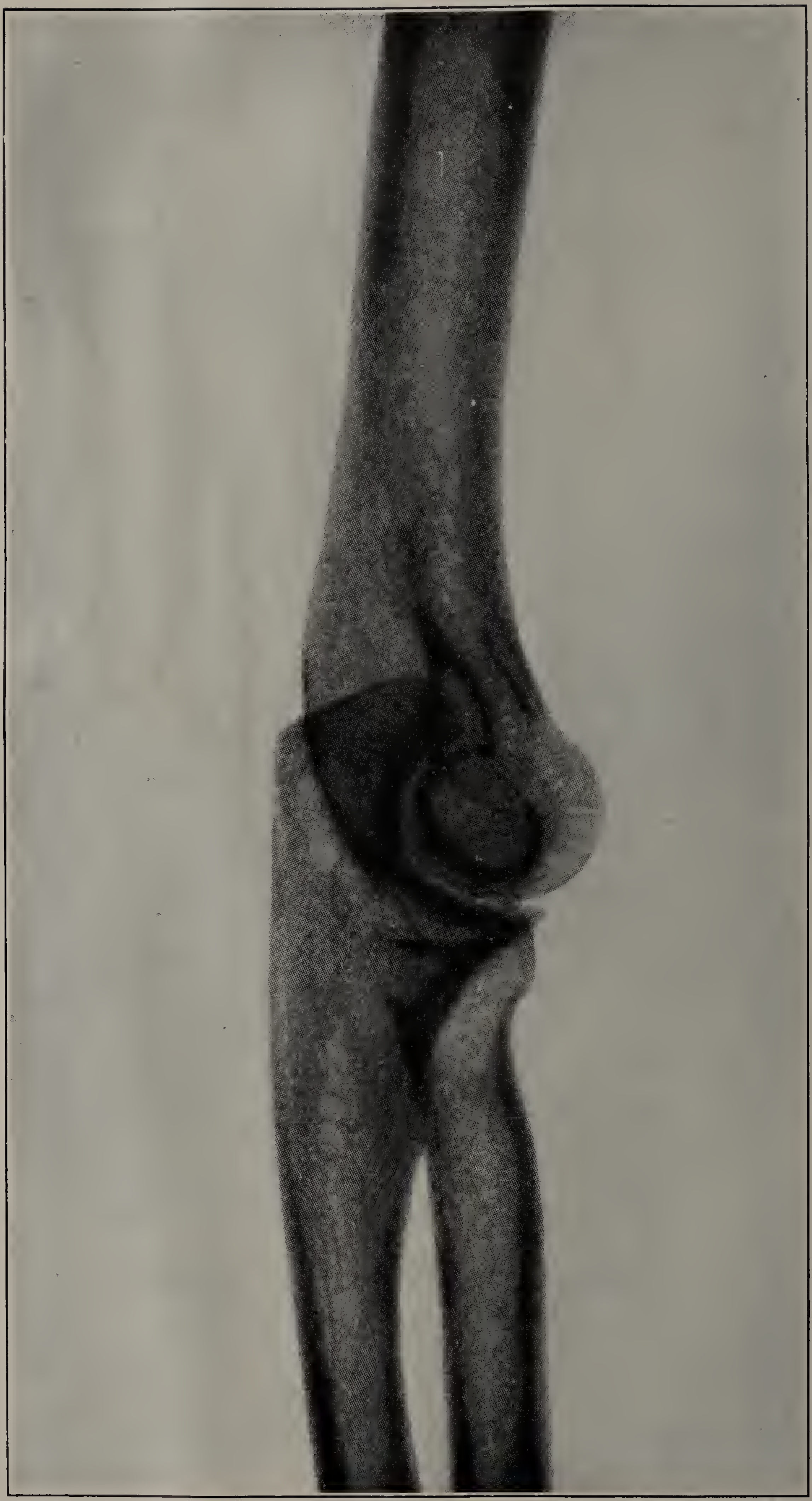


326aa. Right elbow joint.

Extended, hand supinated; volodorsal.

Size, 1 : 1.

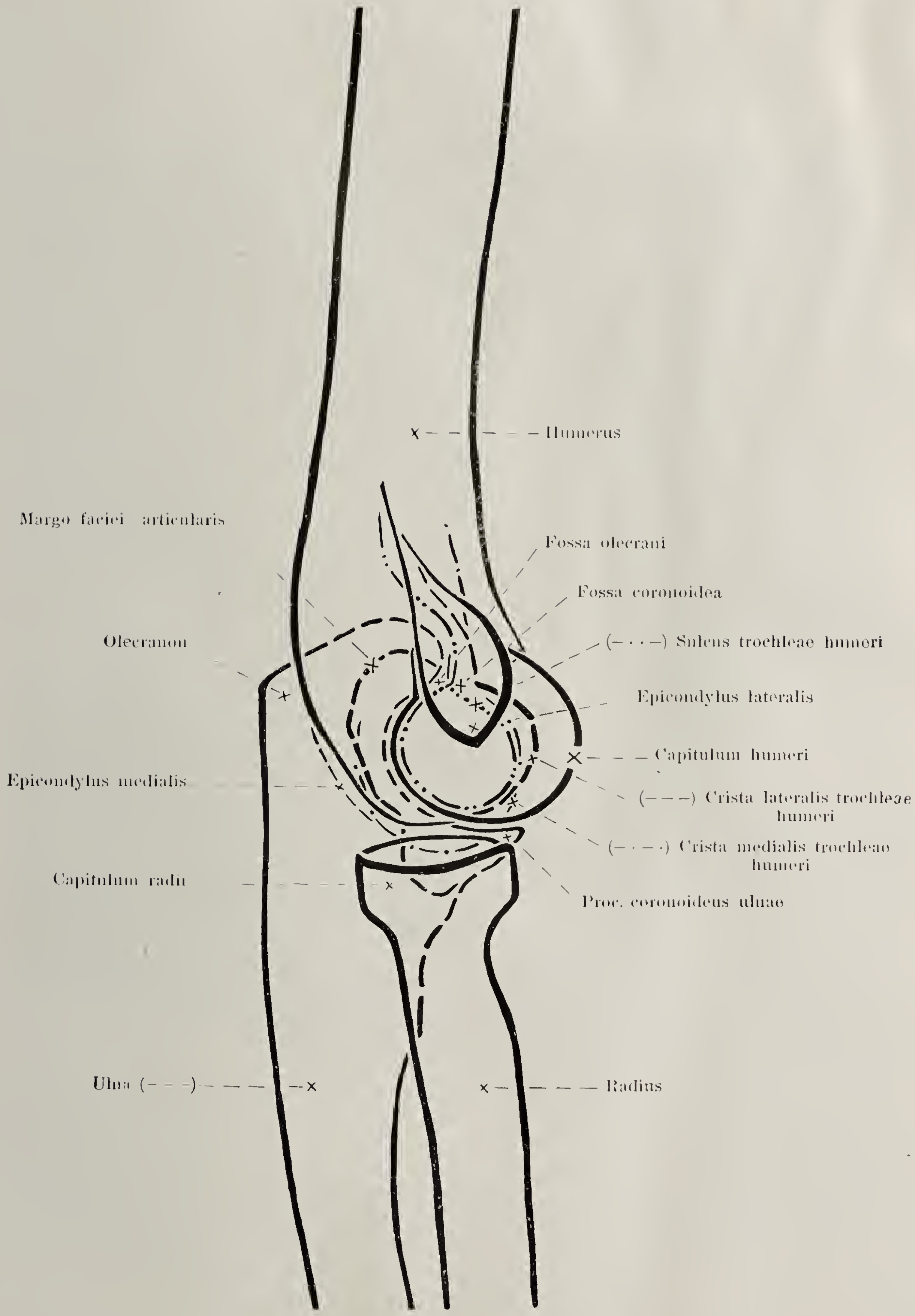
Tracing for figure 326a.



326b. Right elbow joint.

Extended, hand supinated; radioulnar.

Size, 1 : 1.

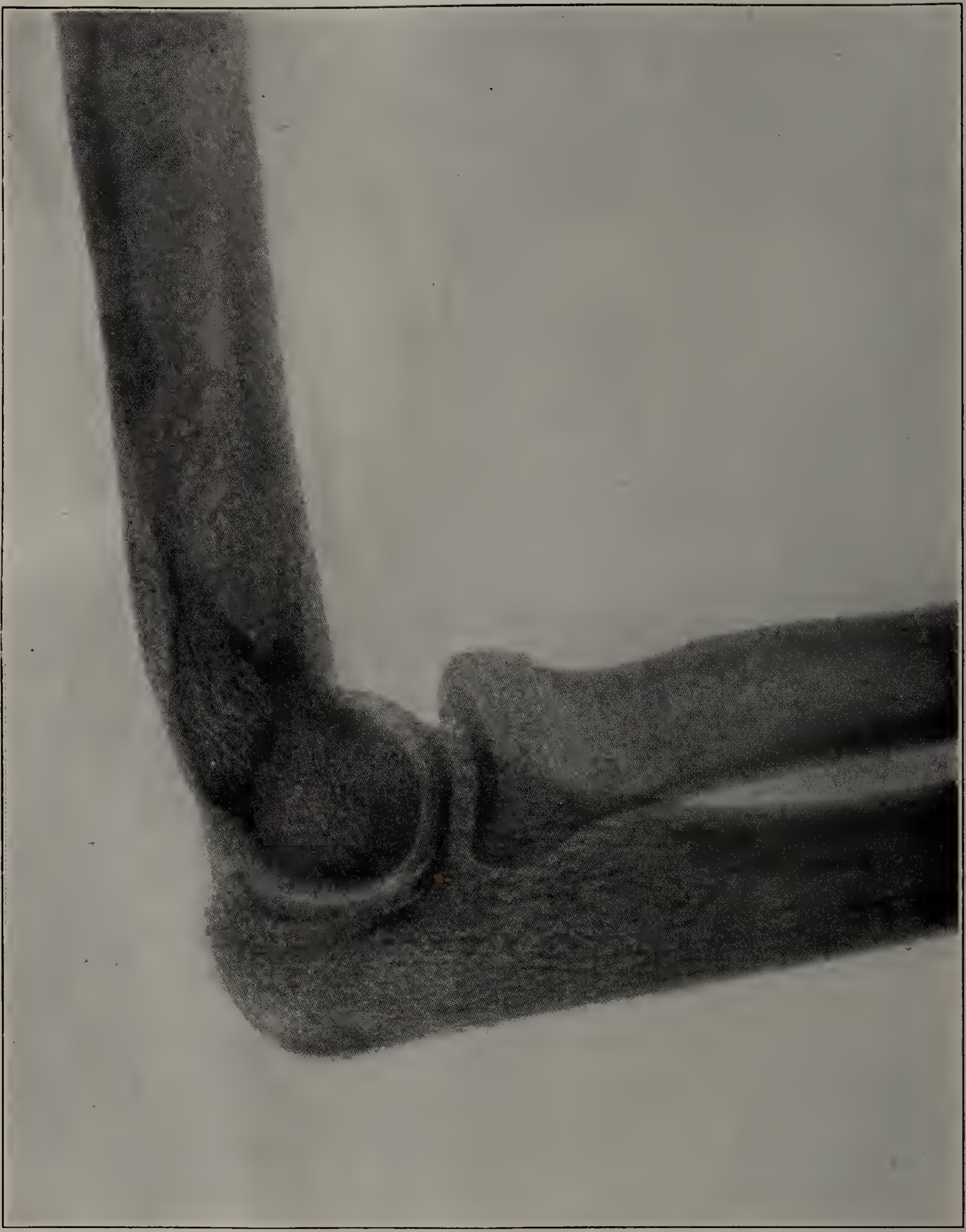


326bb. Right elbow joint.

Extended, hand supinated; radioulnar.

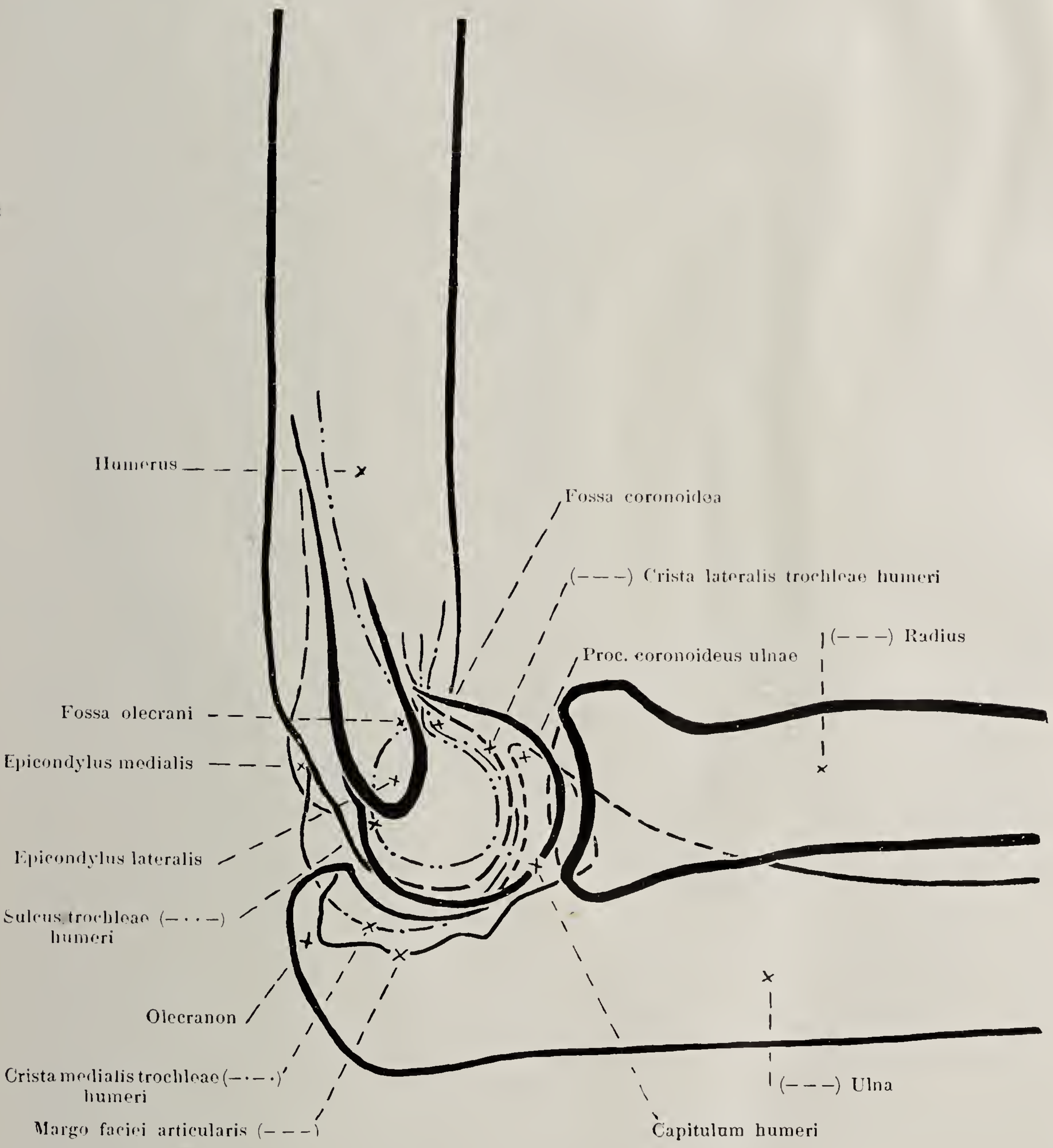
Size, 1 : 1.

Tracing for figure 326b.



326c. Right elbow joint.

Flexed at a right angle, hand supinated; radioulnar.
Size, 1 : 1.

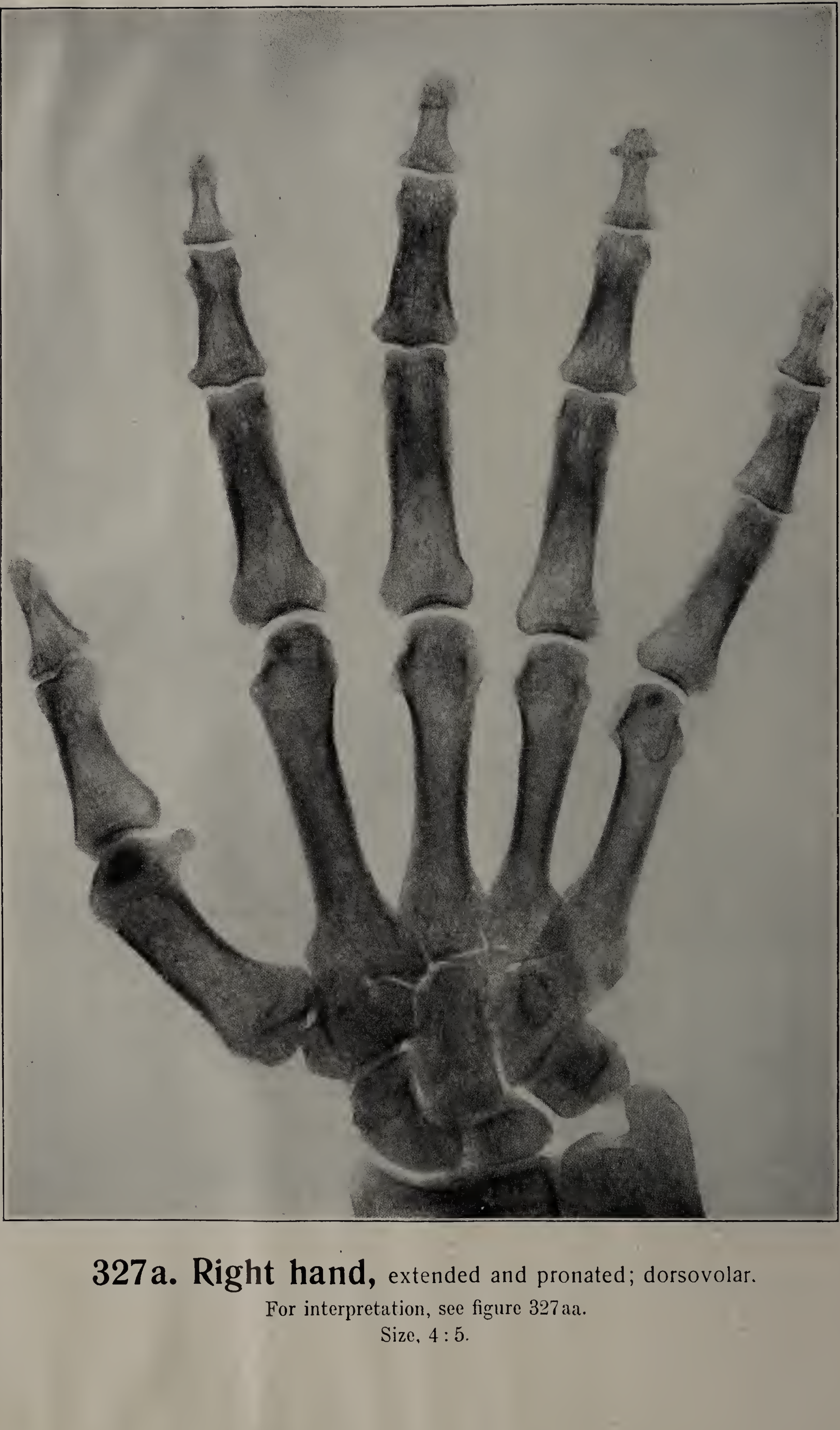


326cc. Right elbow joint.

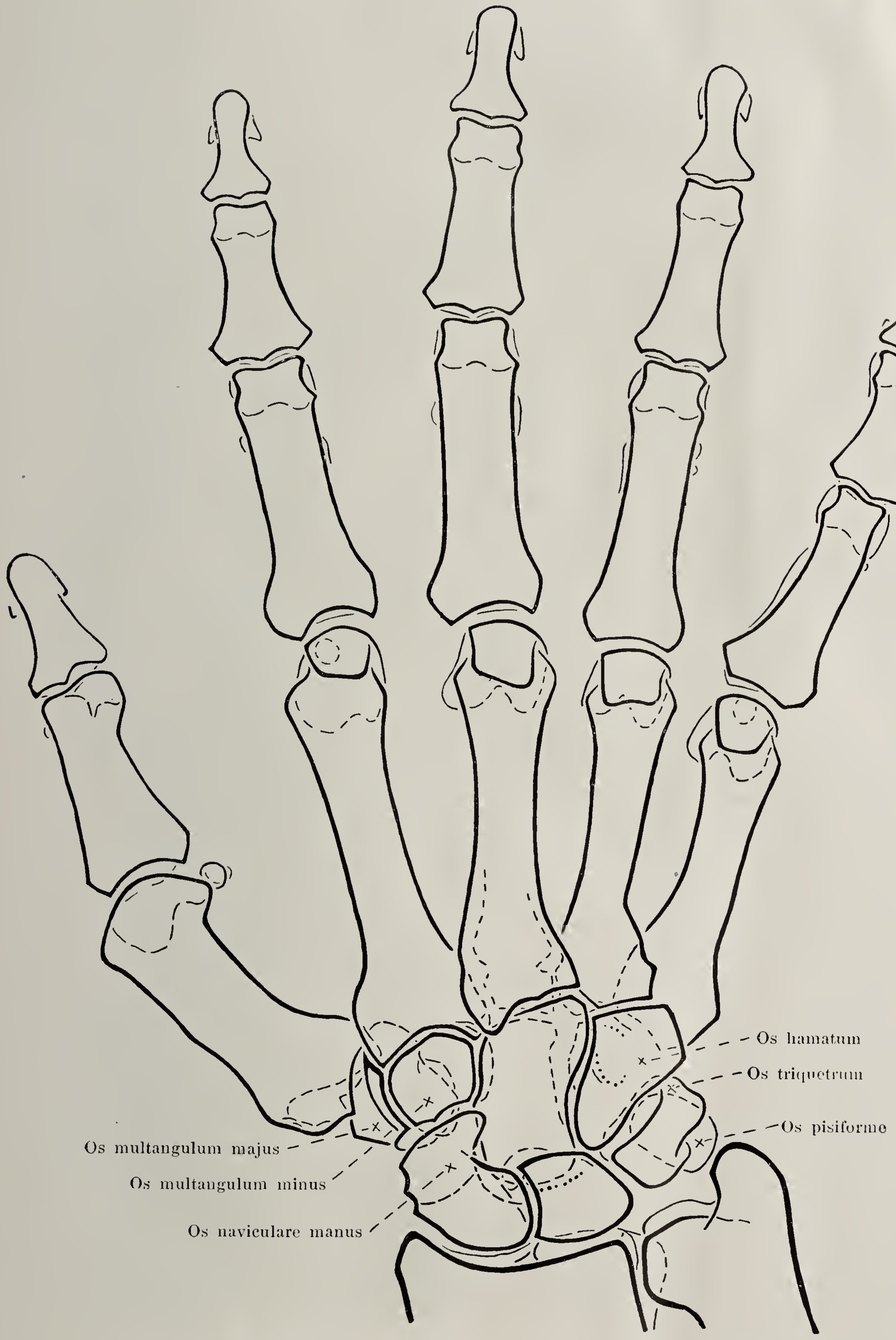
Flexed at a right angle, hand supinated; radioulnar.

Size, 1 : 1.

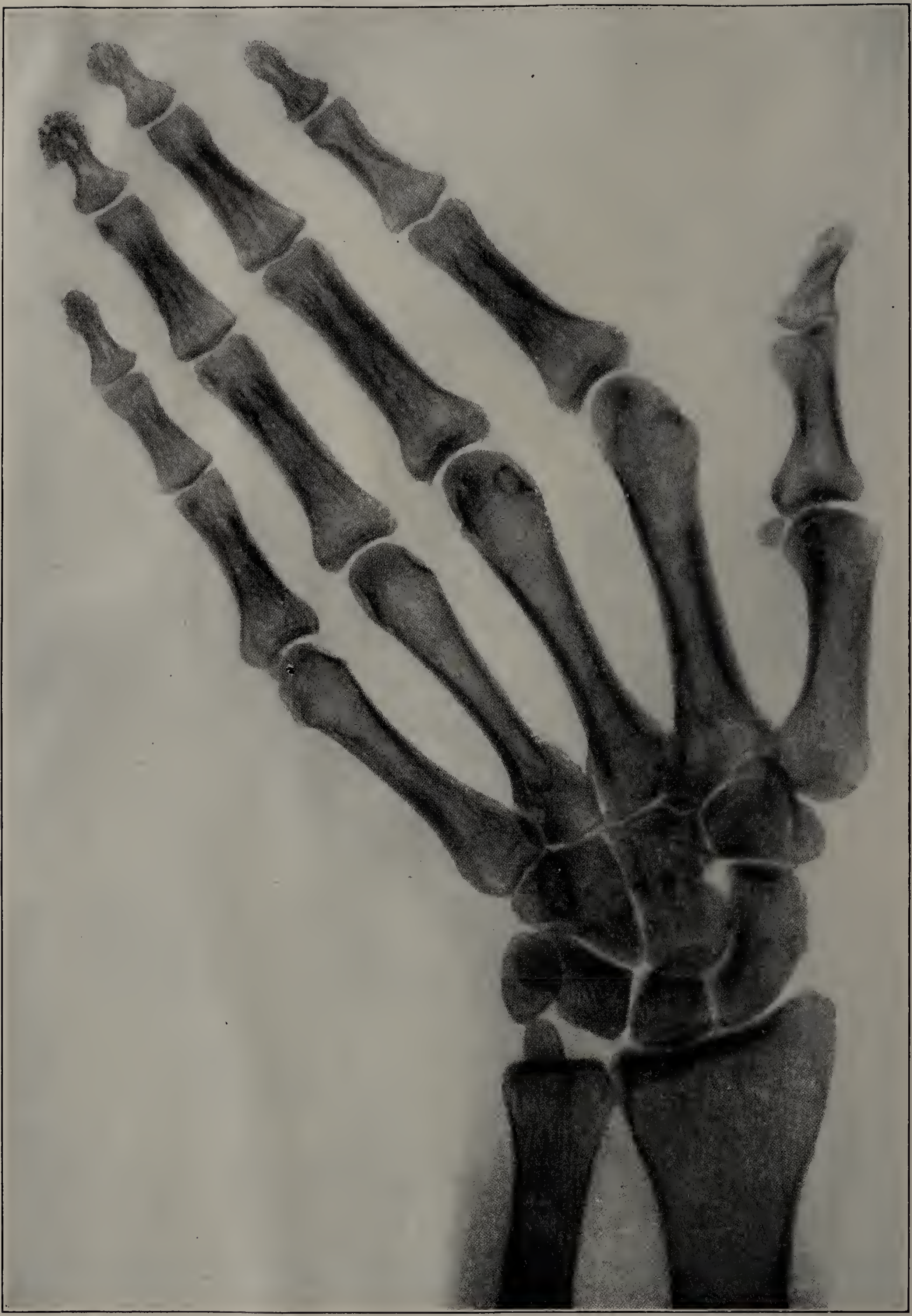
Tracing for figure 326 c.



327a. Right hand, extended and pronated; dorsovolar.
For interpretation, see figure 327aa.
Size, 4 : 5.



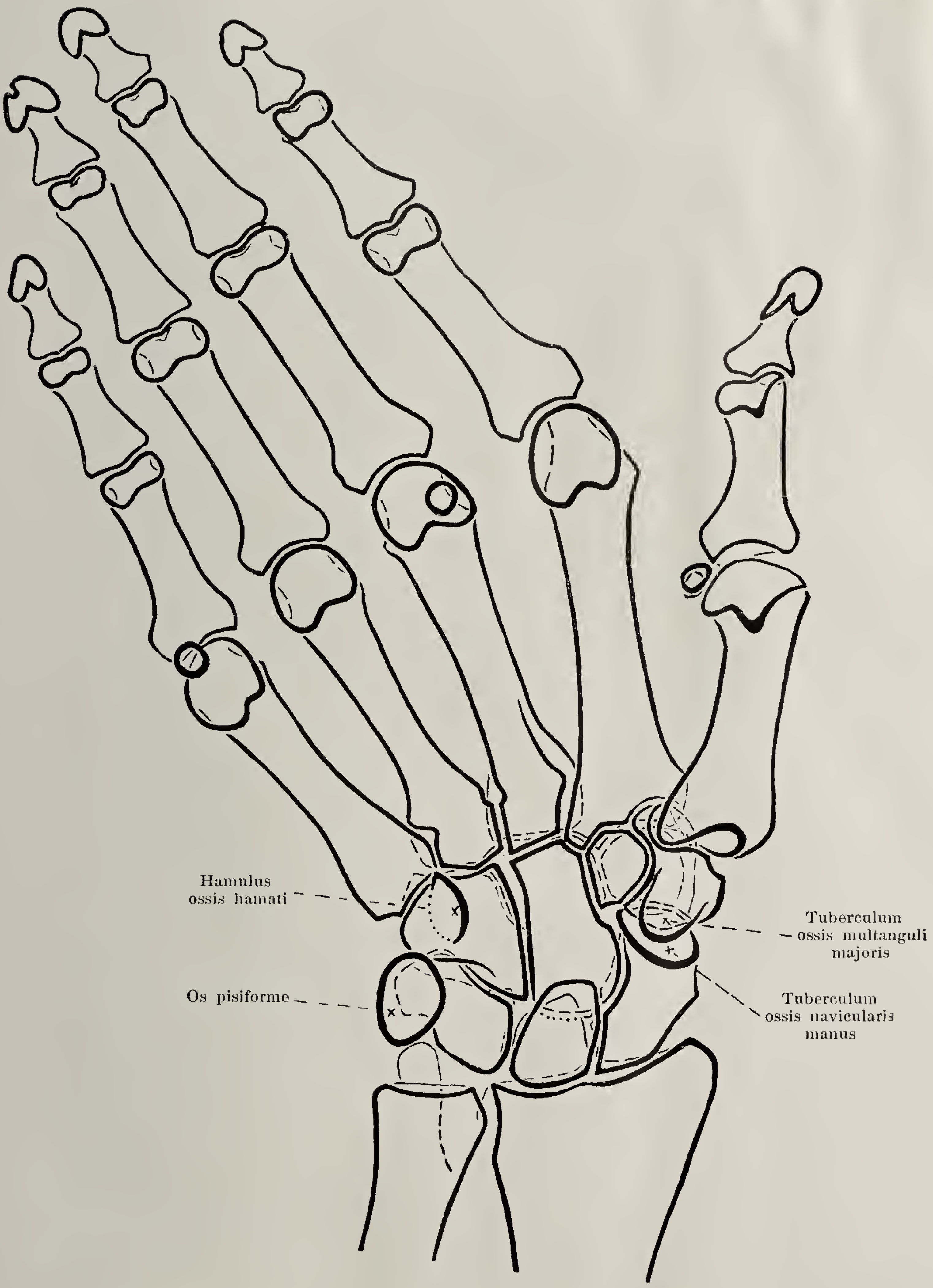
327aa. Right hand, extended and pronated; dorsovolar.
The axial rays are directed toward the articulatio carpometacarpea III.
Size, 4 : 5.
Tracing for figure 327a.



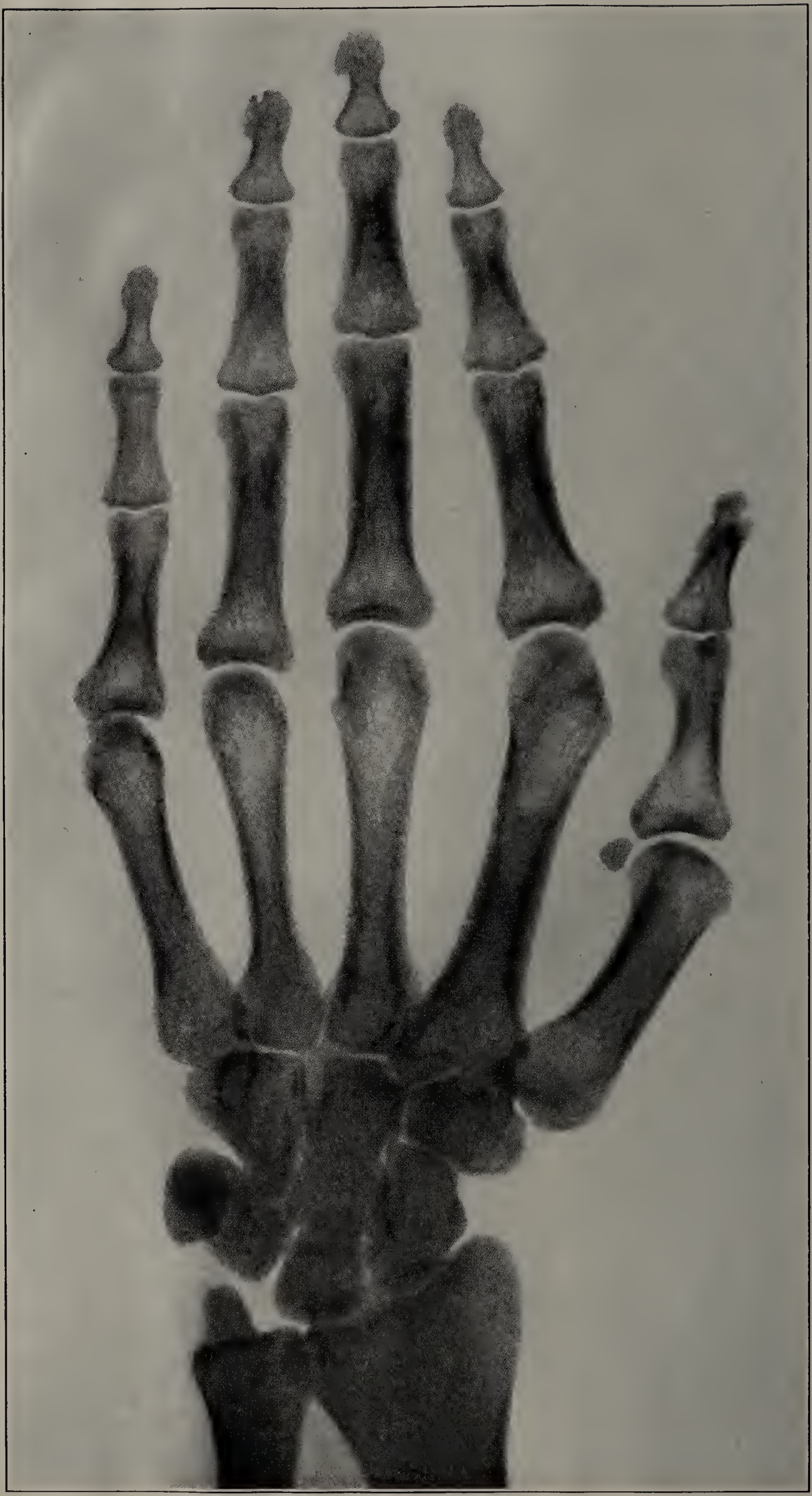
327b. Right hand, extended and supinated, in ulnar abduction; volodorsal.

For interpretation, see figure 327bb. Size, 4 : 5.

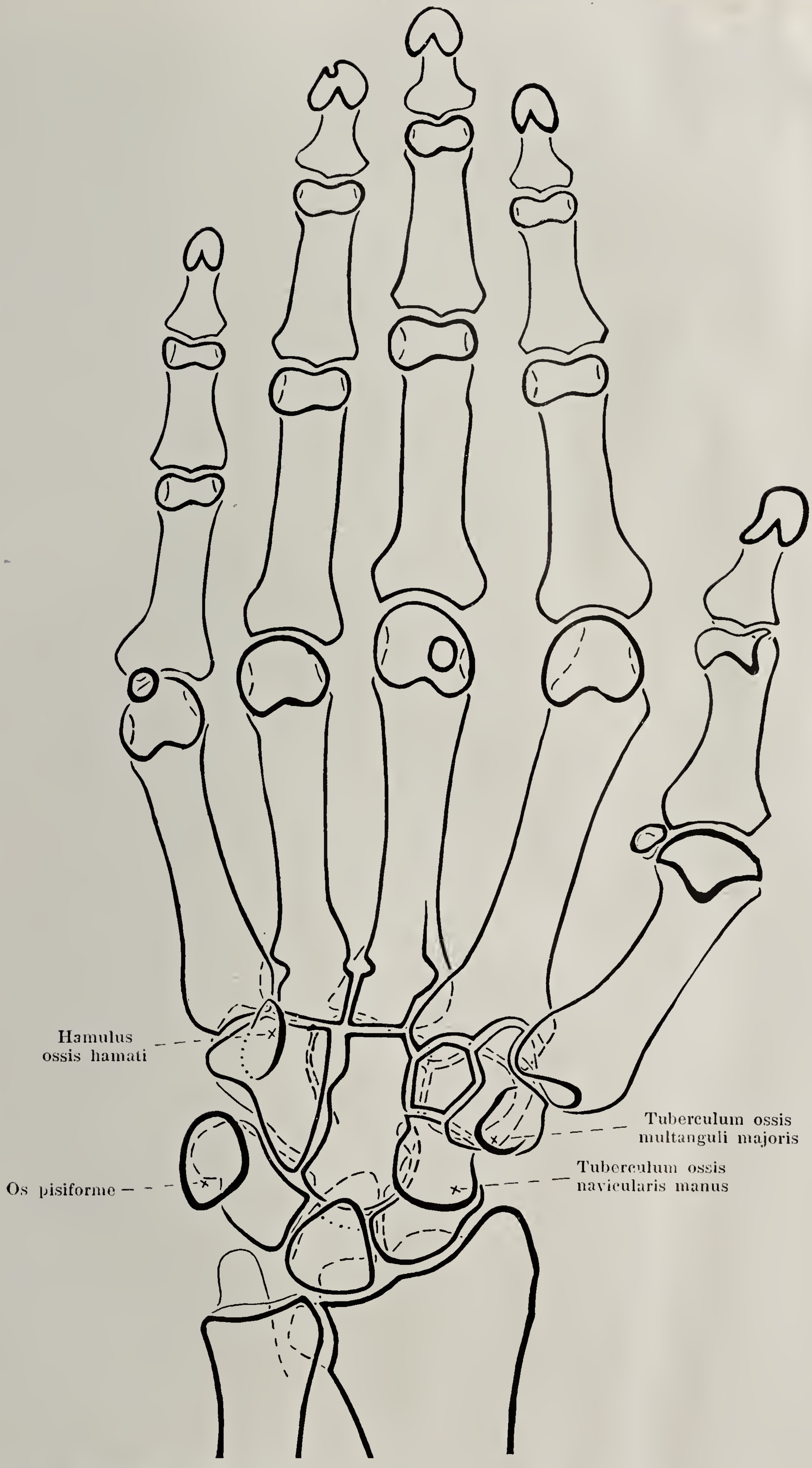
Figure 327b—327cc were taken from the same hand.


Hamulus ossis hamati
Os pisiforme
Tuberculum ossis multanguli majoris
Tuberculum ossis navicularis manus

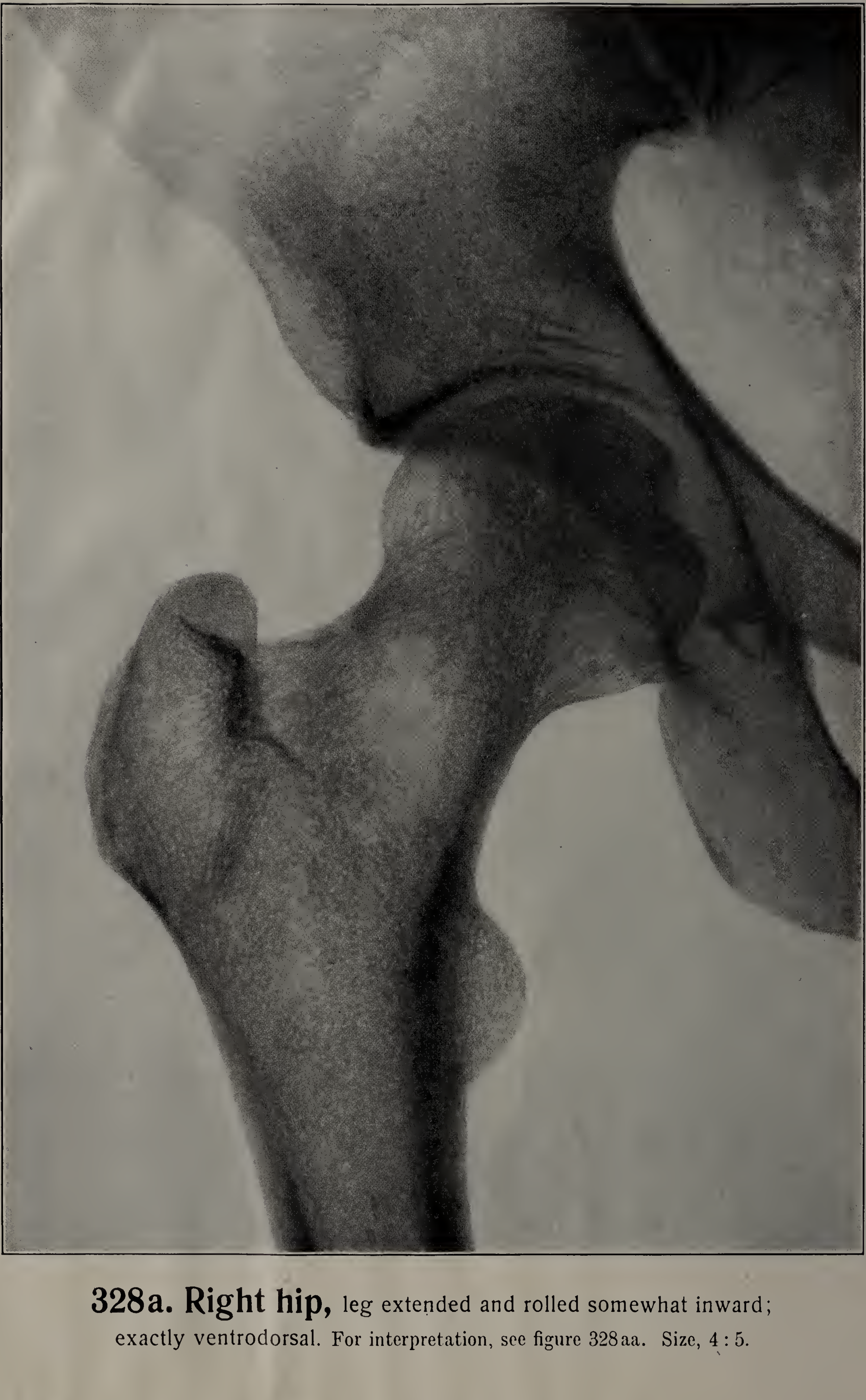
327bb. Right hand, extended and supinated, in ulnar abduction; volodorsal.
The axial rays are directed to the corpus ossi capitati. Size, 4:5.
Tracing for figure 327b.
Figures 327b—327cc were made from the same hand.



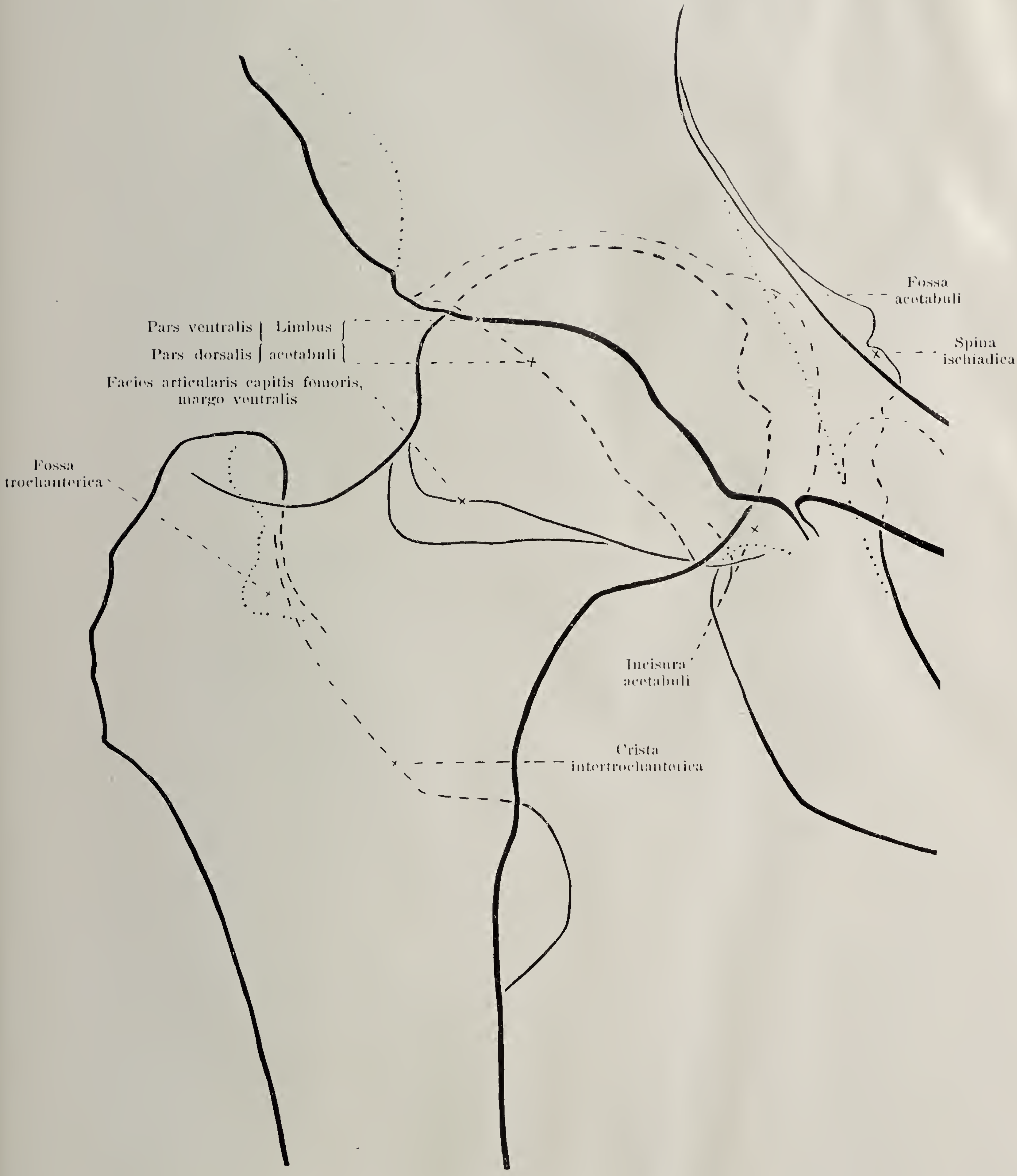
327c. Right hand, extended and supinated, in radial abduction; volodorsal.
For interpretation, see figure 327cc. Size, 4 : 5.
Figures 327b–327cc were made from the same hand.


Hamulus ossis hamati
Os pisiforme
Tuberculum ossis multanguli majoris
Tuberculum ossis navicularis manus

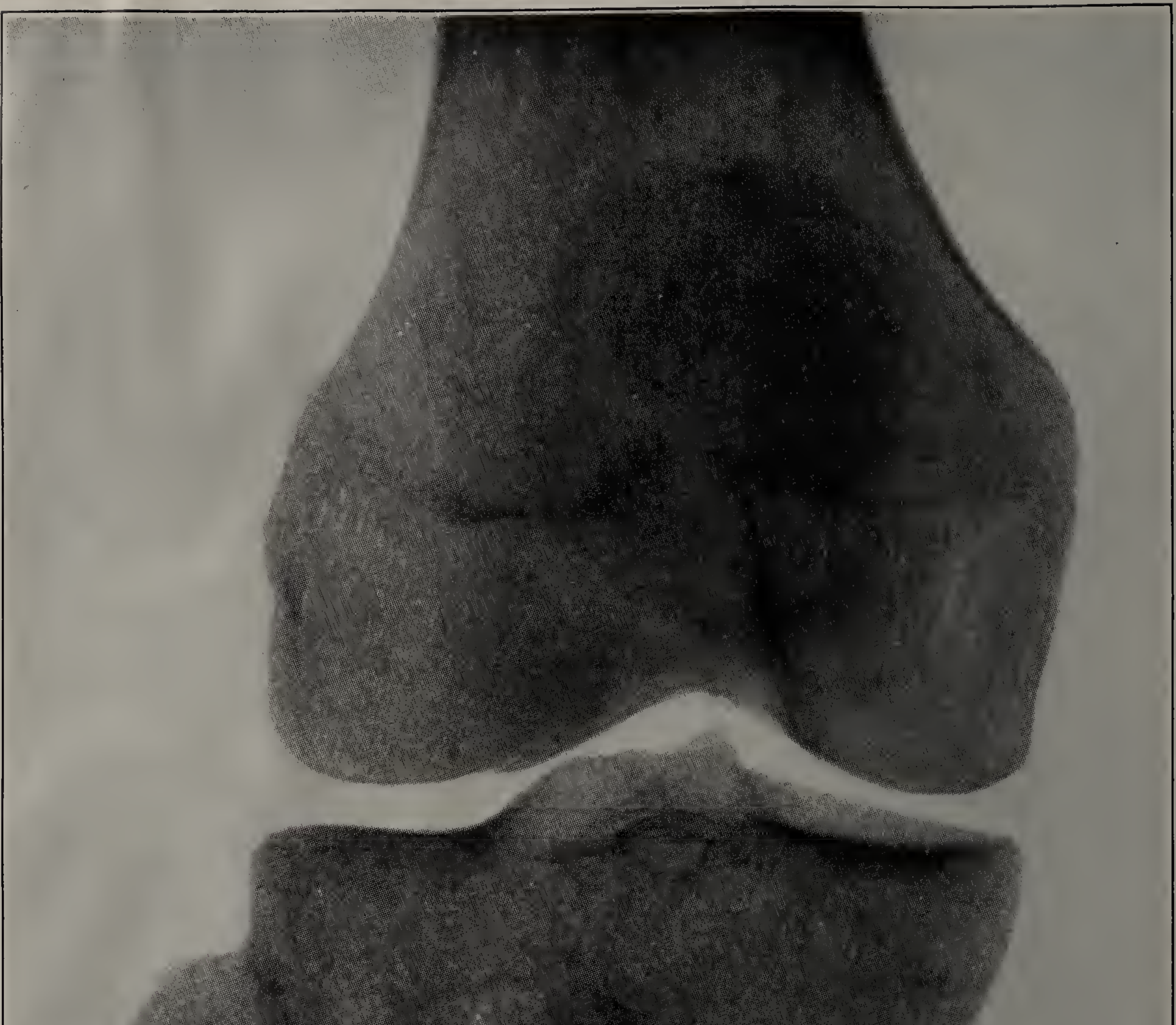
327 cc. Right hand, extended and supinated, in radial abduction; volodorsal.
The axial ray were directed to the corpus ossis capitati. Size, 4:5.
Tracing for figure 327 c.
Figures 327 b—327 cc were made from the same hand.



328a. Right hip, leg extended and rolled somewhat inward; exactly ventrodorsal. For interpretation, see figure 328aa. Size, 4 : 5.



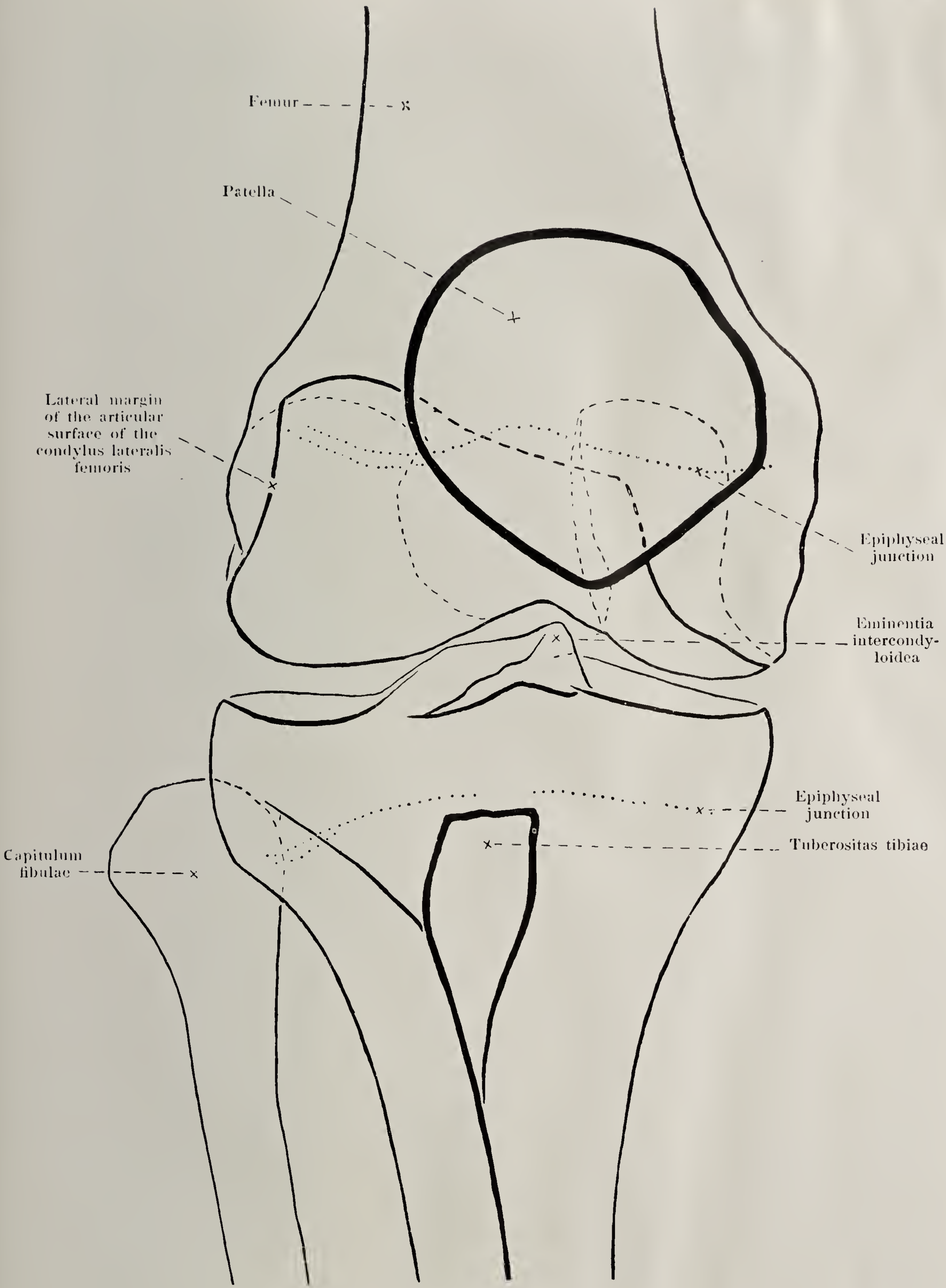
328aa. Right hip, leg extended and rolled somewhat inward; exactly ventrodorsal. Axial rays directed toward the middle of the caput femoris. Size, 4:5. Tracing for figure 328a.



329a. Right knee, extended; ventrodorsal.

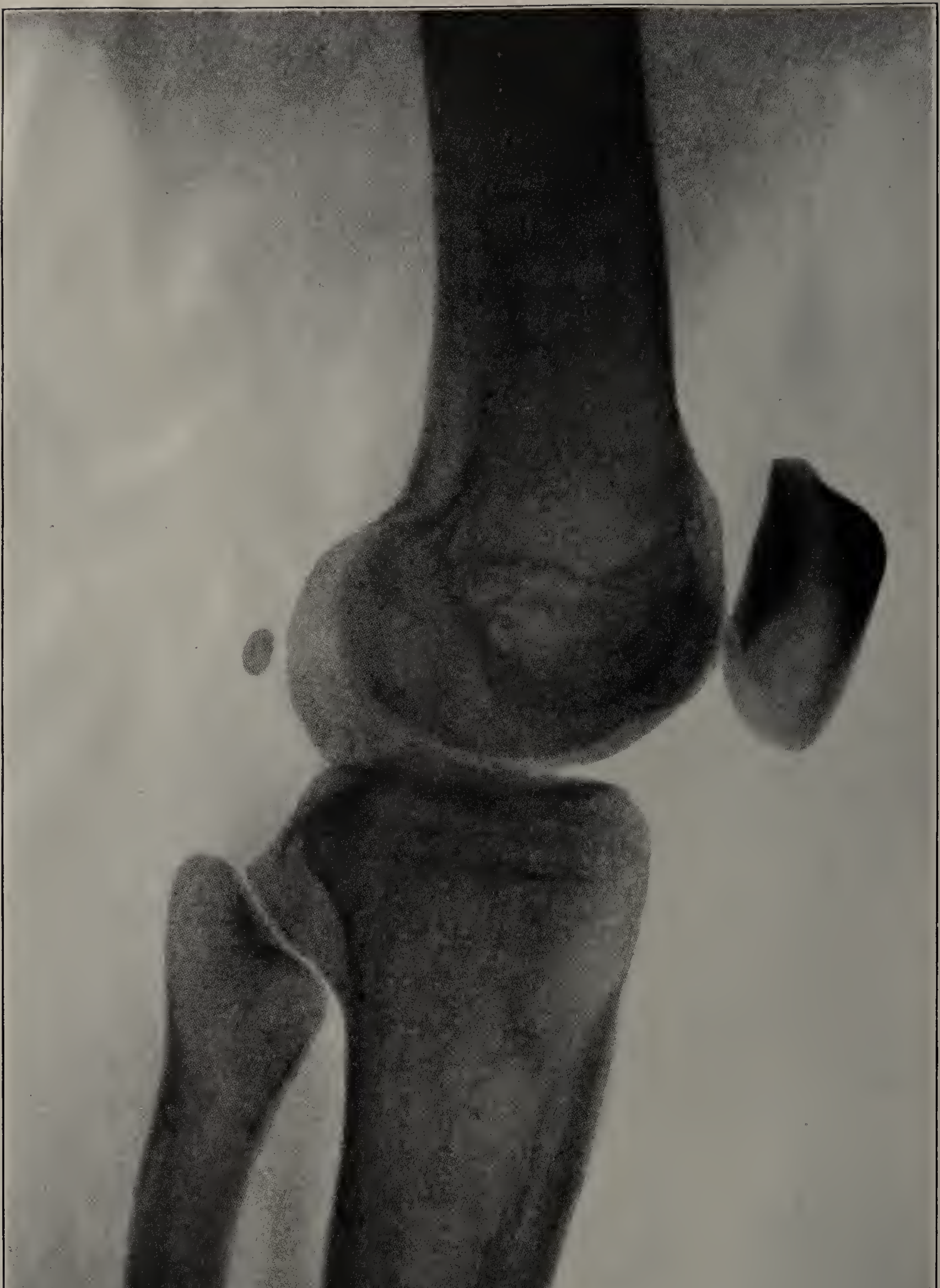
For interpretation, see figure 329aa.

Size, 4 : 5.

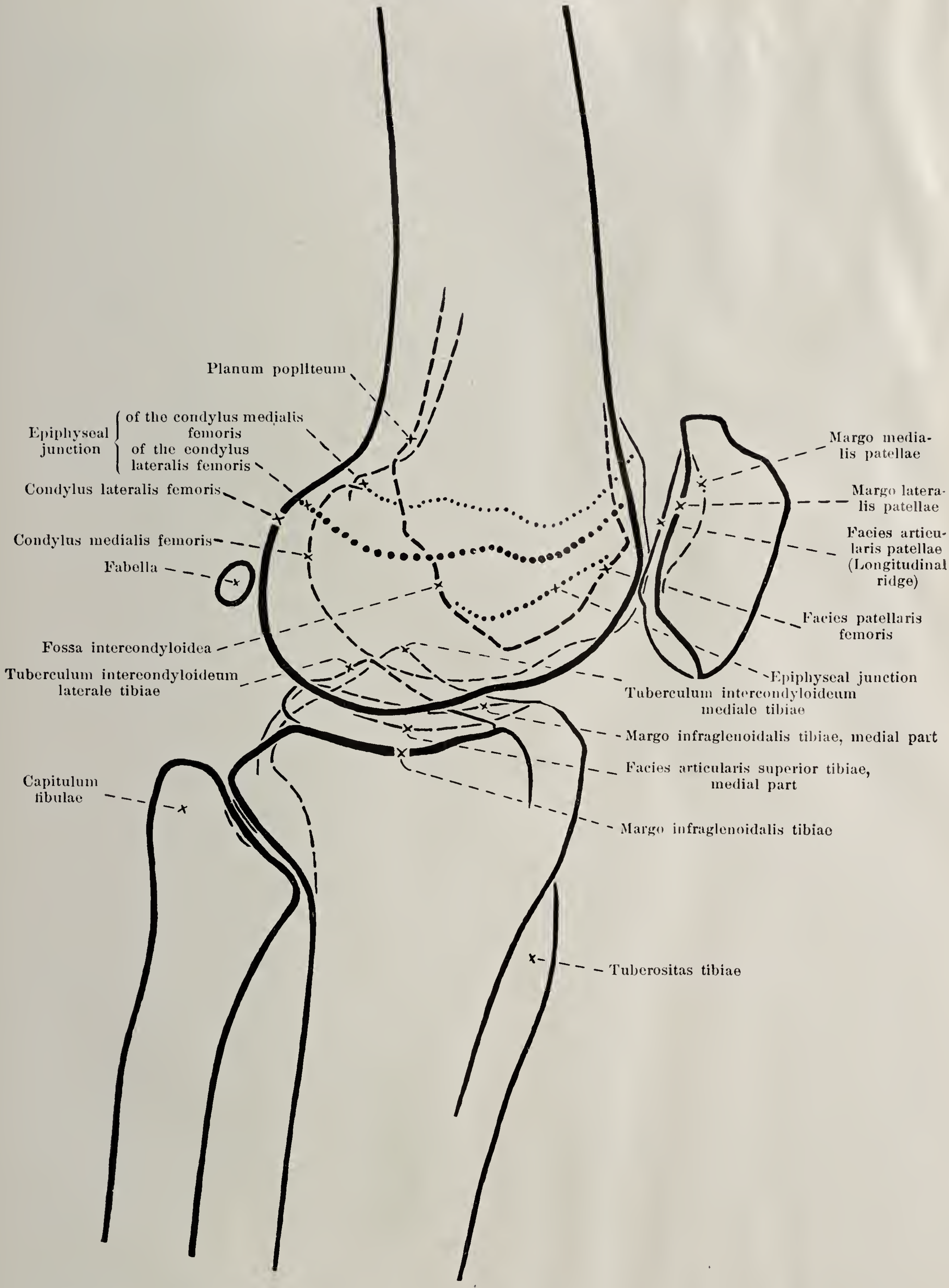

Femur
Patella
Lateral margin of the articular surface of the condylus lateralis femoris
Epiphyseal junction
Eminentia intercondyloidea
Epiphyseal junction
Tuberositas tibiae
Capitulum fibulae

329aa. Right knee, extended; ventrodorsal.
Axial rays directed to a spot somewhat beneath the patella.

Size, 4:5.
Tracing for figure 329a.

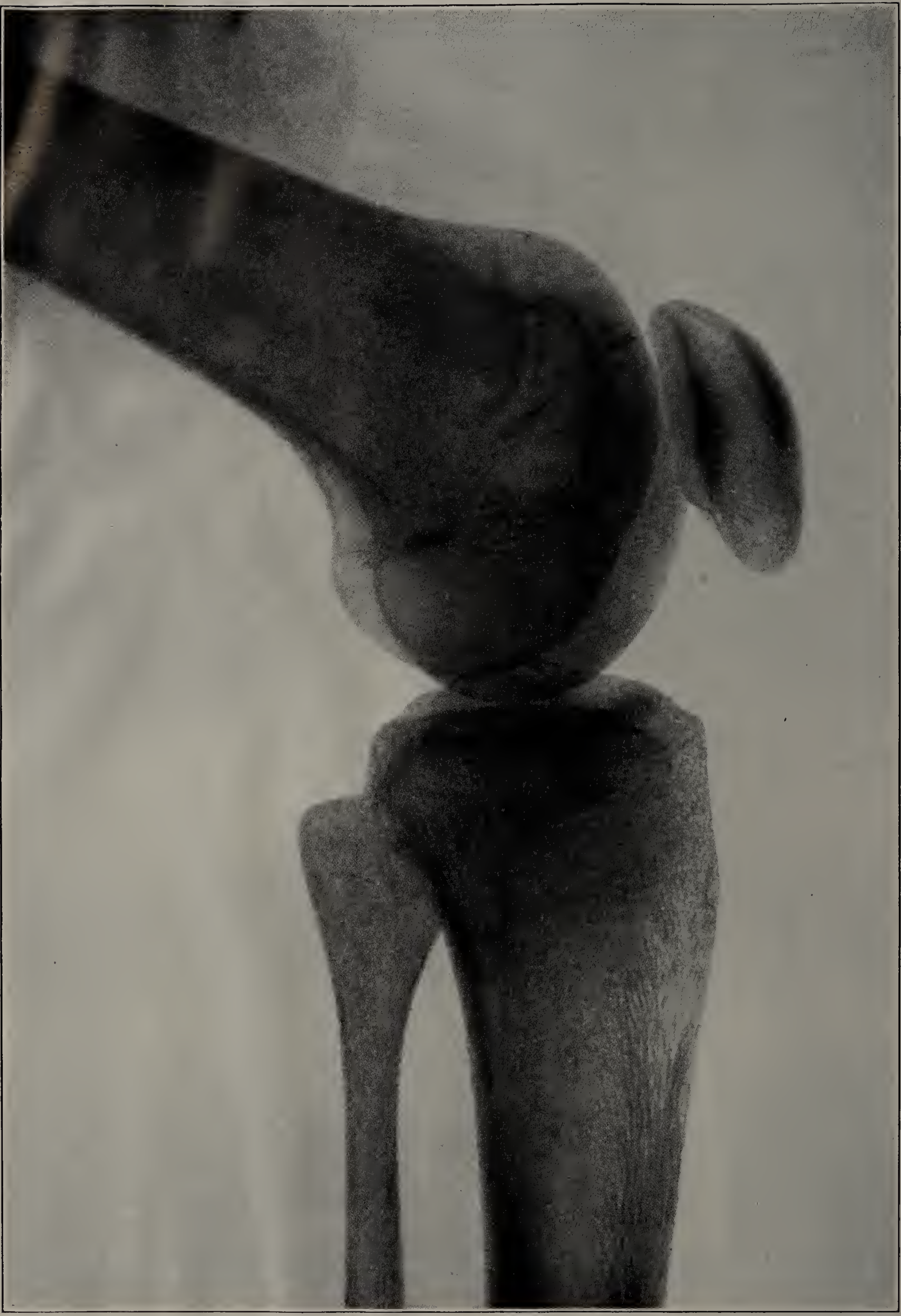


329 b. Right knee, extended; lateromedial.
For interpretation, see figure 329 bb. Size, 4 : 5.

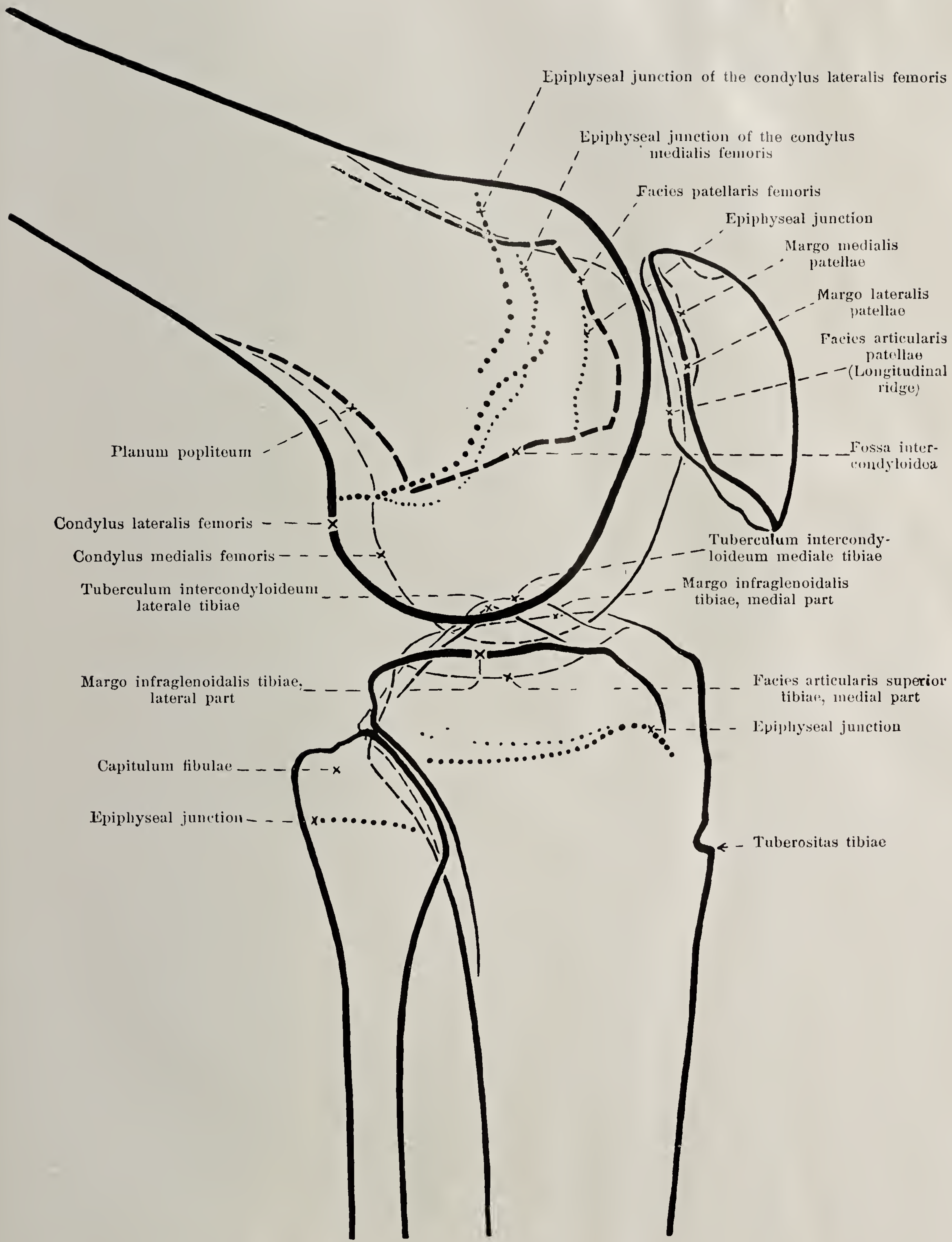

Planum popliteum
Epiphyseal junction of the condylus medialis femoris
of the condylus lateralis femoris
Condylus lateralis femoris
Condylus medialis femoris
Fabella
Fossa intercondyloidea
Tuberculum intercondyloideum laterale tibiae
Capitulum fibulae
Margo medialis patellae
Margo lateralis patellae
Facies articularis patellae (Longitudinal ridge)
Facies patellaris femoris
Epiphyseal junction
Tuberculum intercondyloideum mediale tibiae
Margo infraglenoidalis tibiae, medial part
Facies articularis superior tibiae, medial part
Margo infraglenoidalis tibiae
Tuberositas tibiae

329bb. Right knee, extended; lateromedial. Axial rays directed to a spot ventral and somewhat proximal from the epicondylis lateralis femoris.

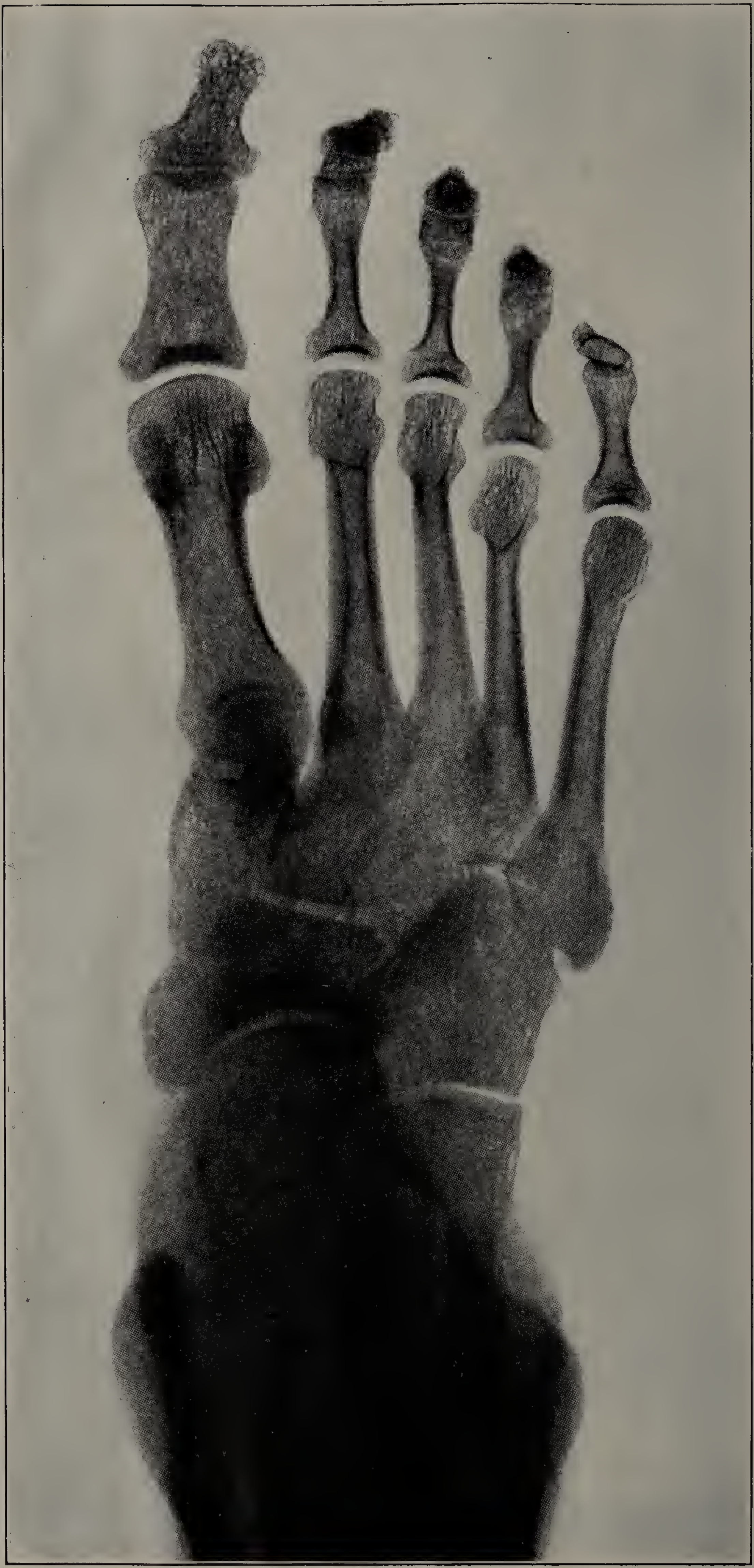
Size, 4 : 5. Tracing for figure 329b.



329c. Right knee, flexed; lateromedial.
For interpretation, see figure 329cc. Size, 4 : 5.

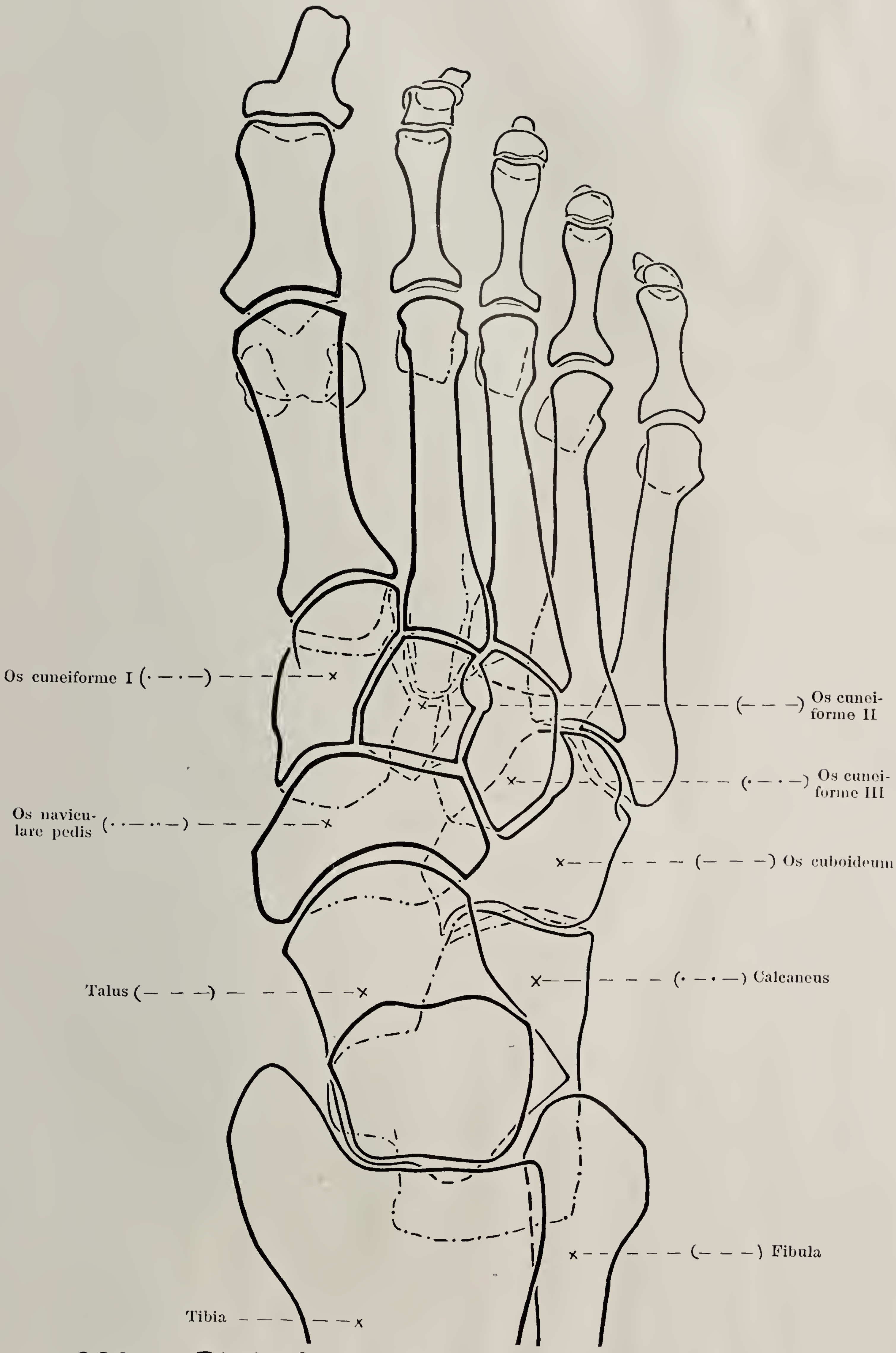

Epiphyseal junction of the condylus lateralis femoris
Epiphyseal junction of the condylus medialis femoris
Facies patellaris femoris
Epiphyseal junction
Margo medialis patellae
Margo lateralis patellae
Facies articularis patellae (Longitudinal ridge)
Planum popliteum
Fossa intercondyloidea
Condylus lateralis femoris
Condylus medialis femoris
Tuberculum intercondyloideum mediale tibiae
Tuberculum intercondyloideum laterale tibiae
Margo infraglenoidalis tibiae, medial part
Margo infraglenoidalis tibiae, lateral part
Facies articularis superior tibiae, medial part
Epiphyseal junction
Capitulum fibulae
Epiphyseal junction
Tuberositas tibiae

329cc. Right knee, flexed; lateromedial. Axial rays directed to a spot ventral and somewhat distal from the epicondylis lateralis femoris.
Size, 4:5. Tracing for figure 329c.



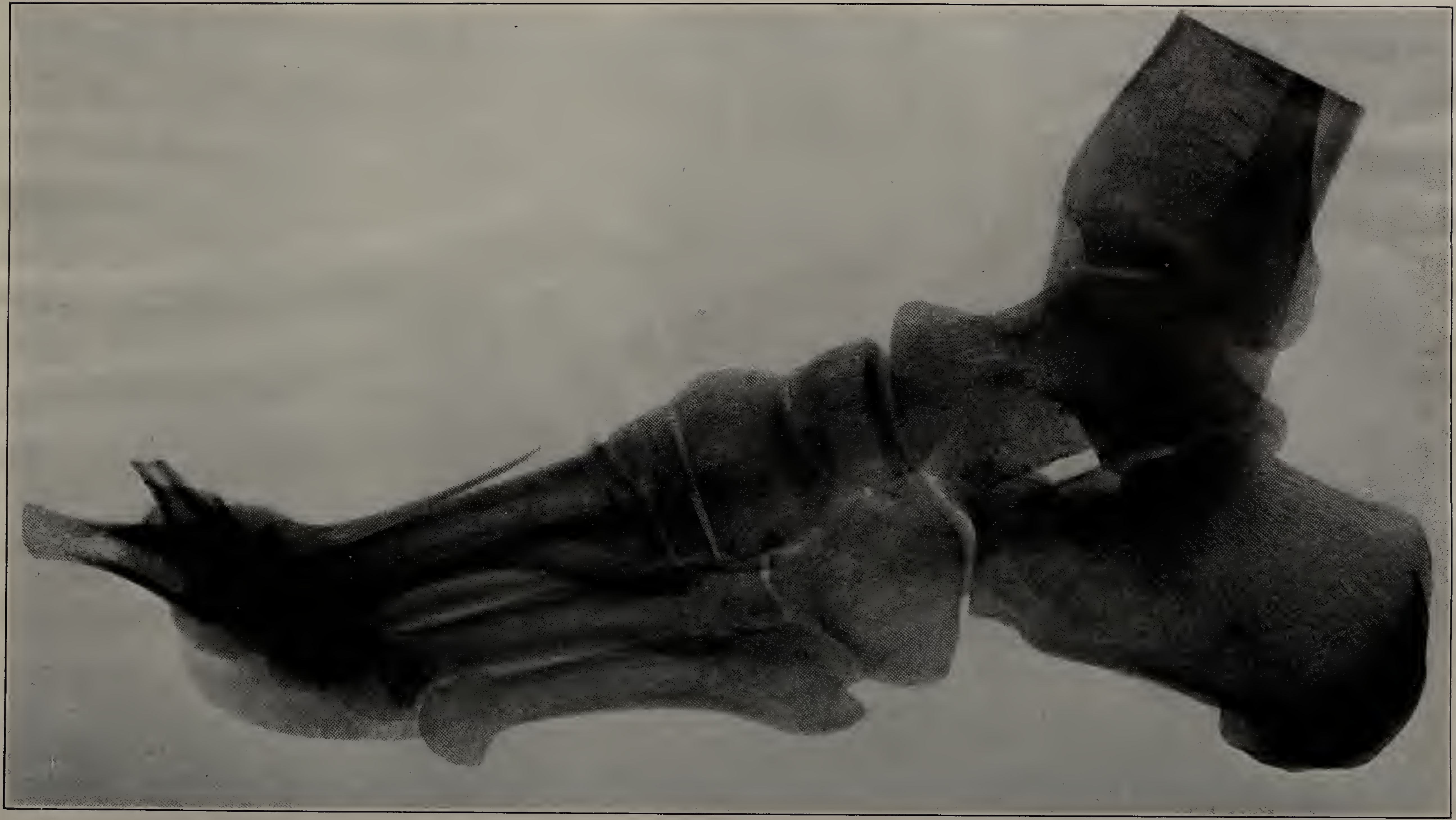
330a. Right foot, plantar flexion; dorso-plantar.

Size, 4 : 5.

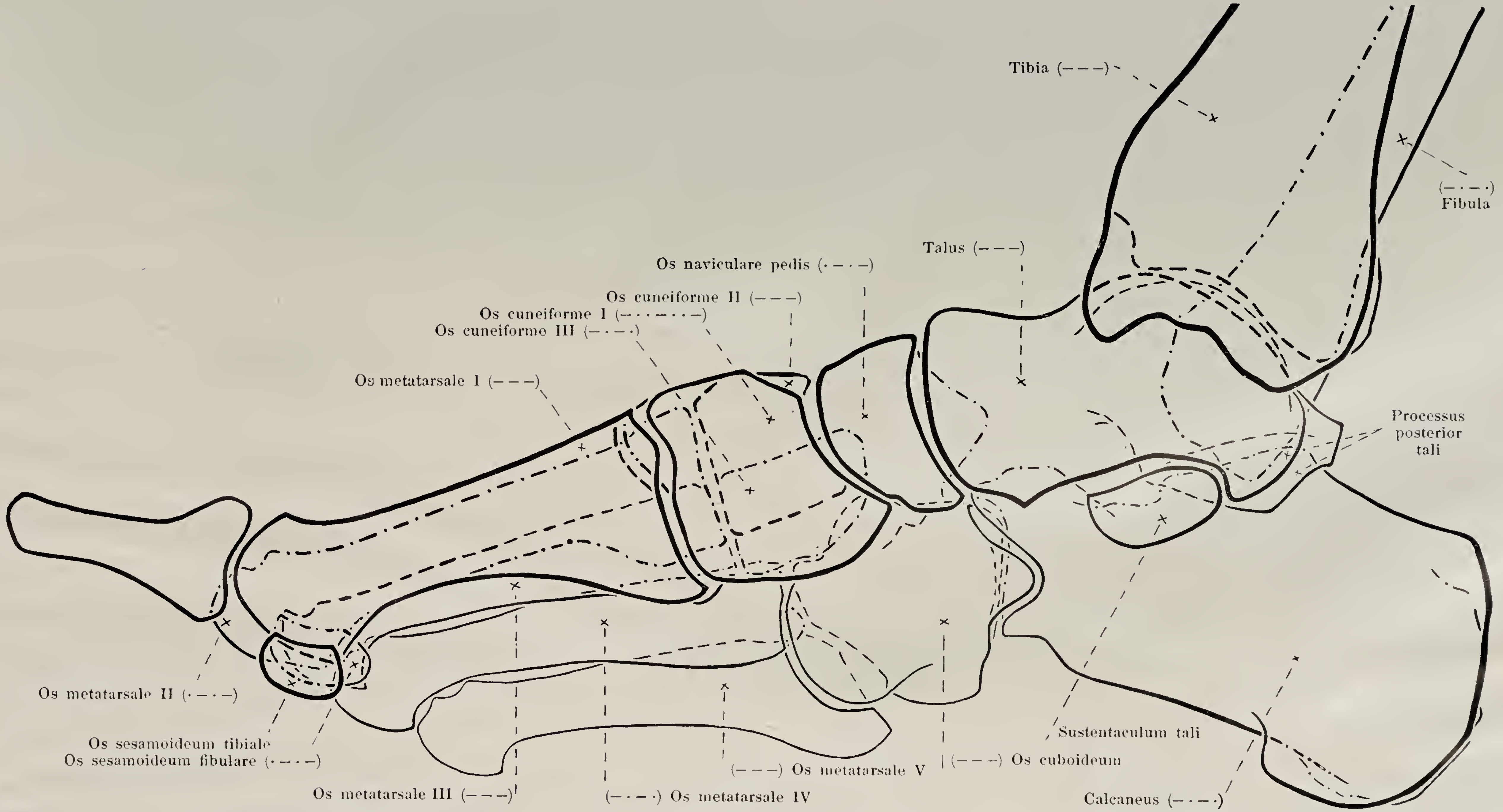


330aa. Right foot, plantar flexion; dorso-plantar. Size, 4 : 5.

Tracing for figure 330a.



331a. Right foot, in slight plantar flexion, recumbent position; medio-lateral view. Size, 4 : 5.
(The dark transverse lines on the tibia are due to inequalities of bony growth, such as are observed in rickets



331aa. Right foot, slight plantar flexion, recumbent position; medio-lateral view. Size, 4:5.
Tracing for figure 331a.

HAND-ATLAS
OF
HUMAN ANATOMY

BY

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PROFESSOR OF ANATOMY IN THE UNIVERSITY AT LEIPZIG

TRANSLATED BY

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JOHNS HOPKINS HOSPITAL, BALTIMORE

SEVENTH EDITION IN ENGLISH

VOL. II
REGIONS, MUSCLES, FASCIÆ, HEART, BLOOD-VESSELS

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J. B. LIPPINCOTT COMPANY

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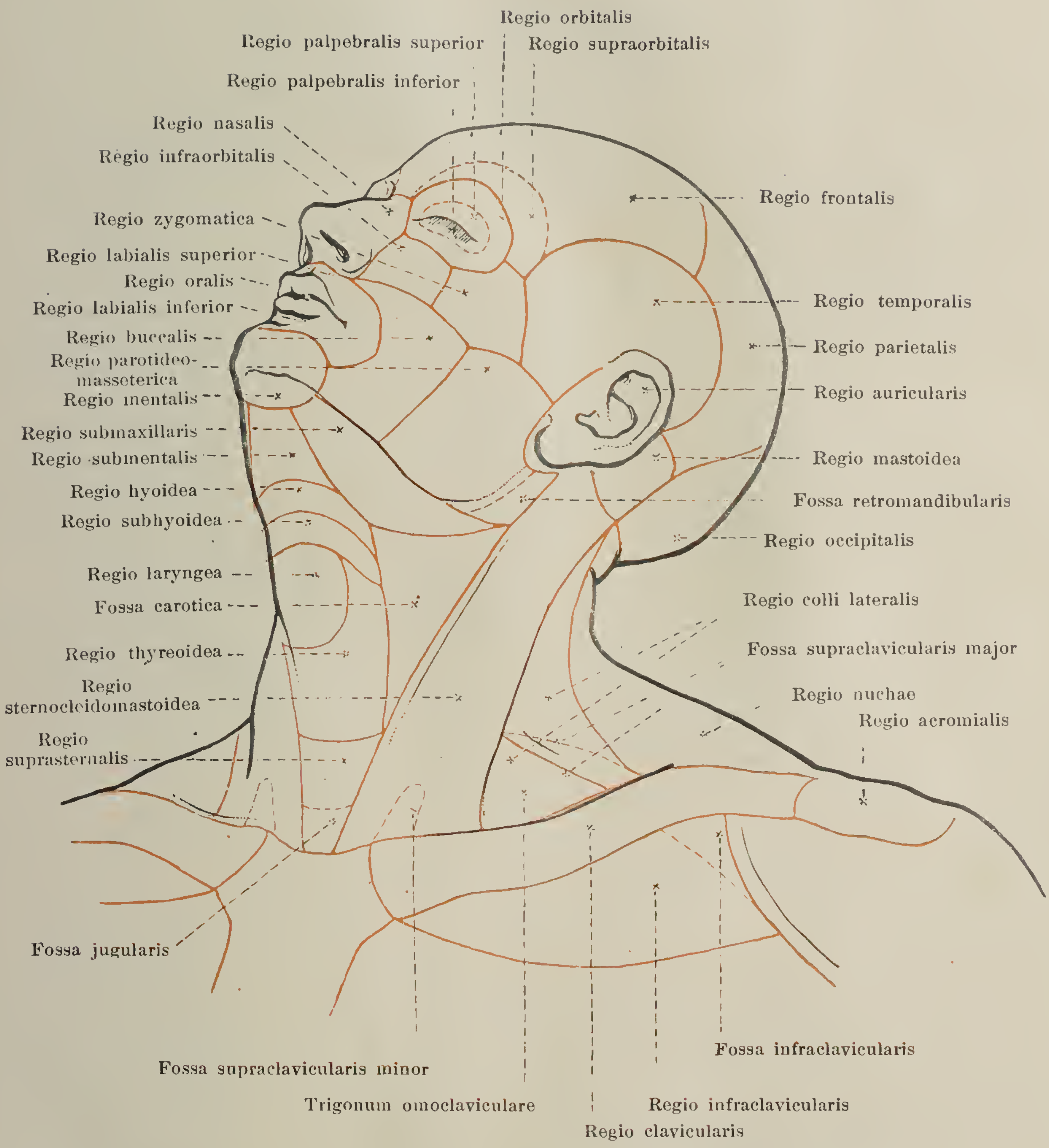
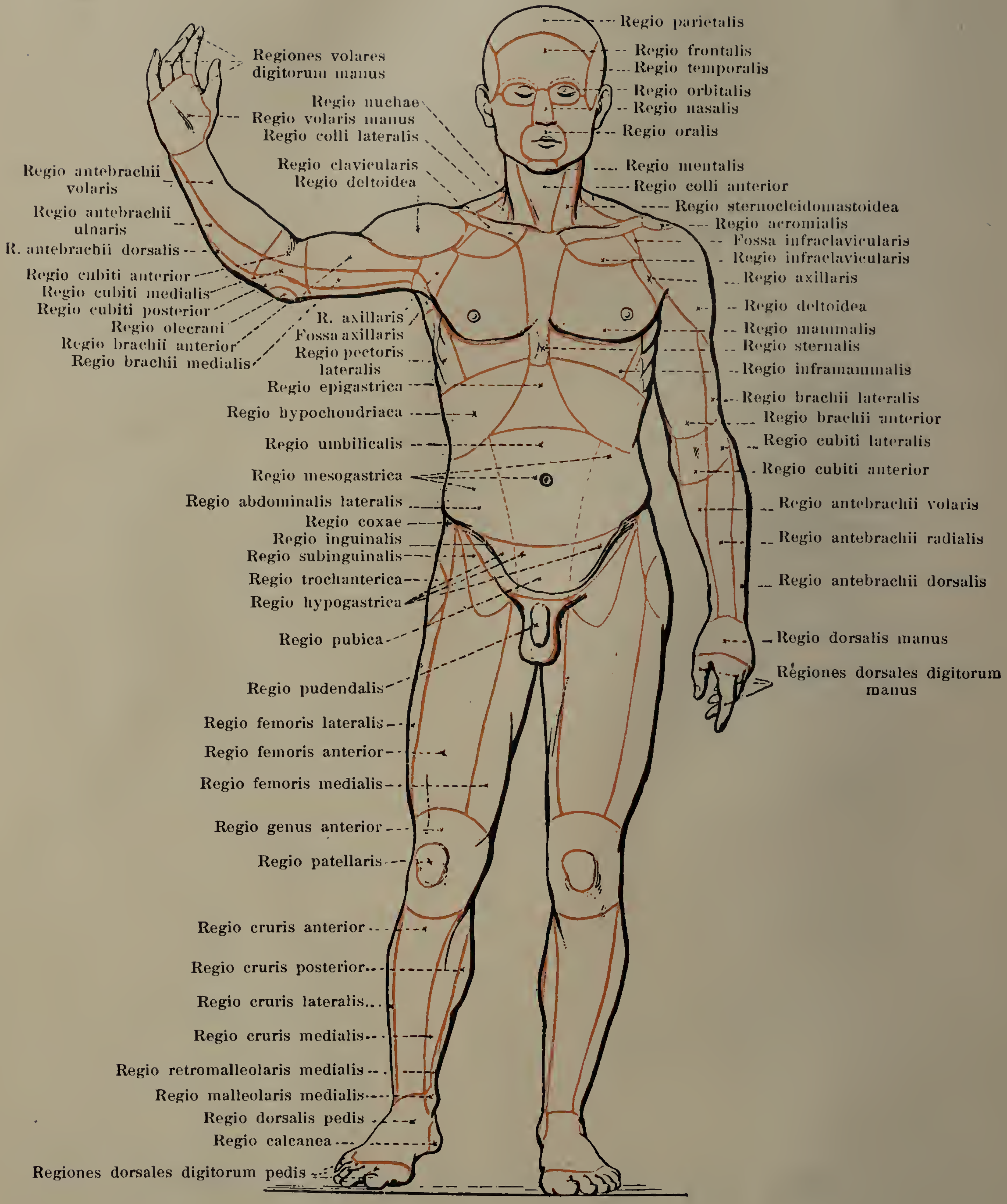
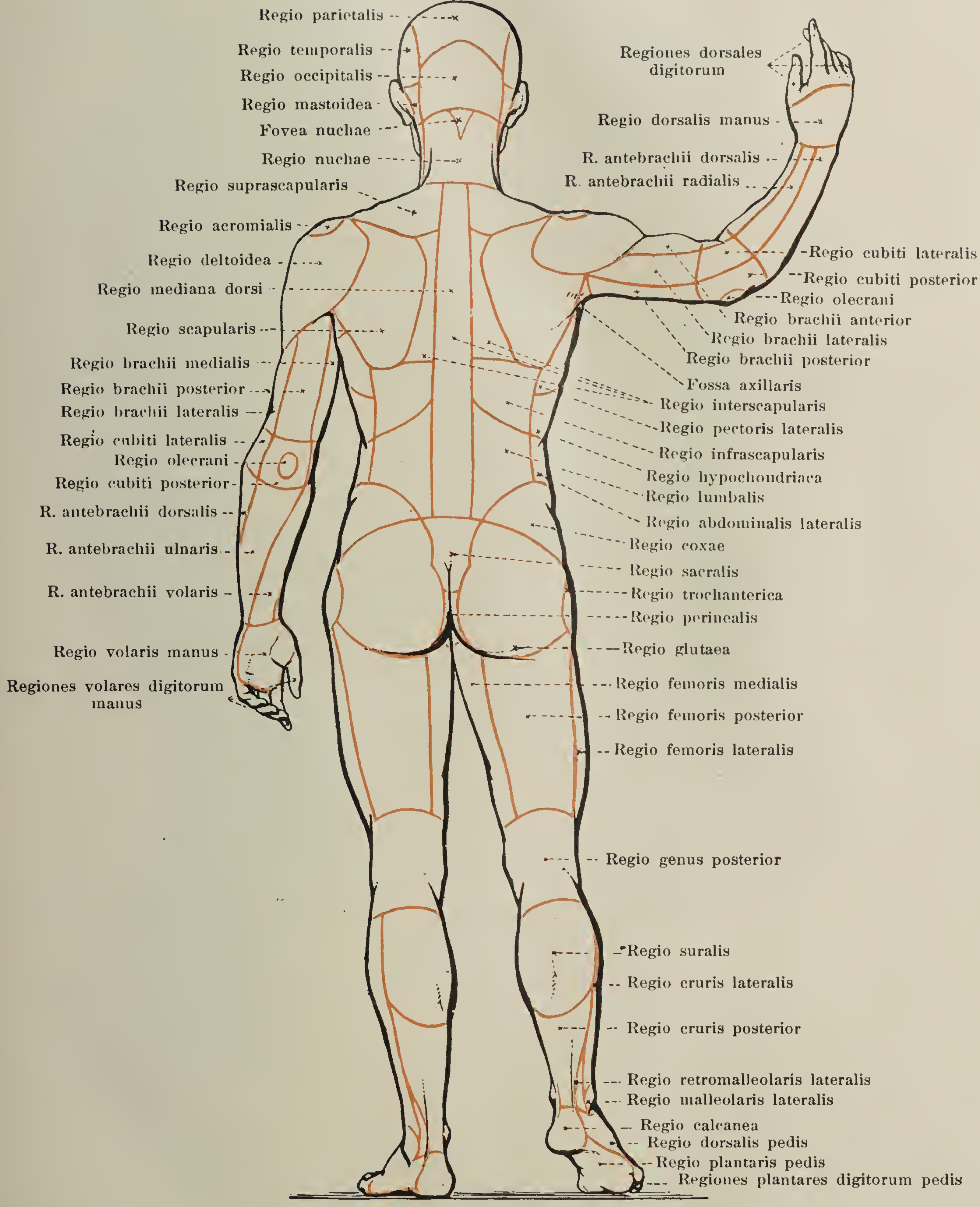


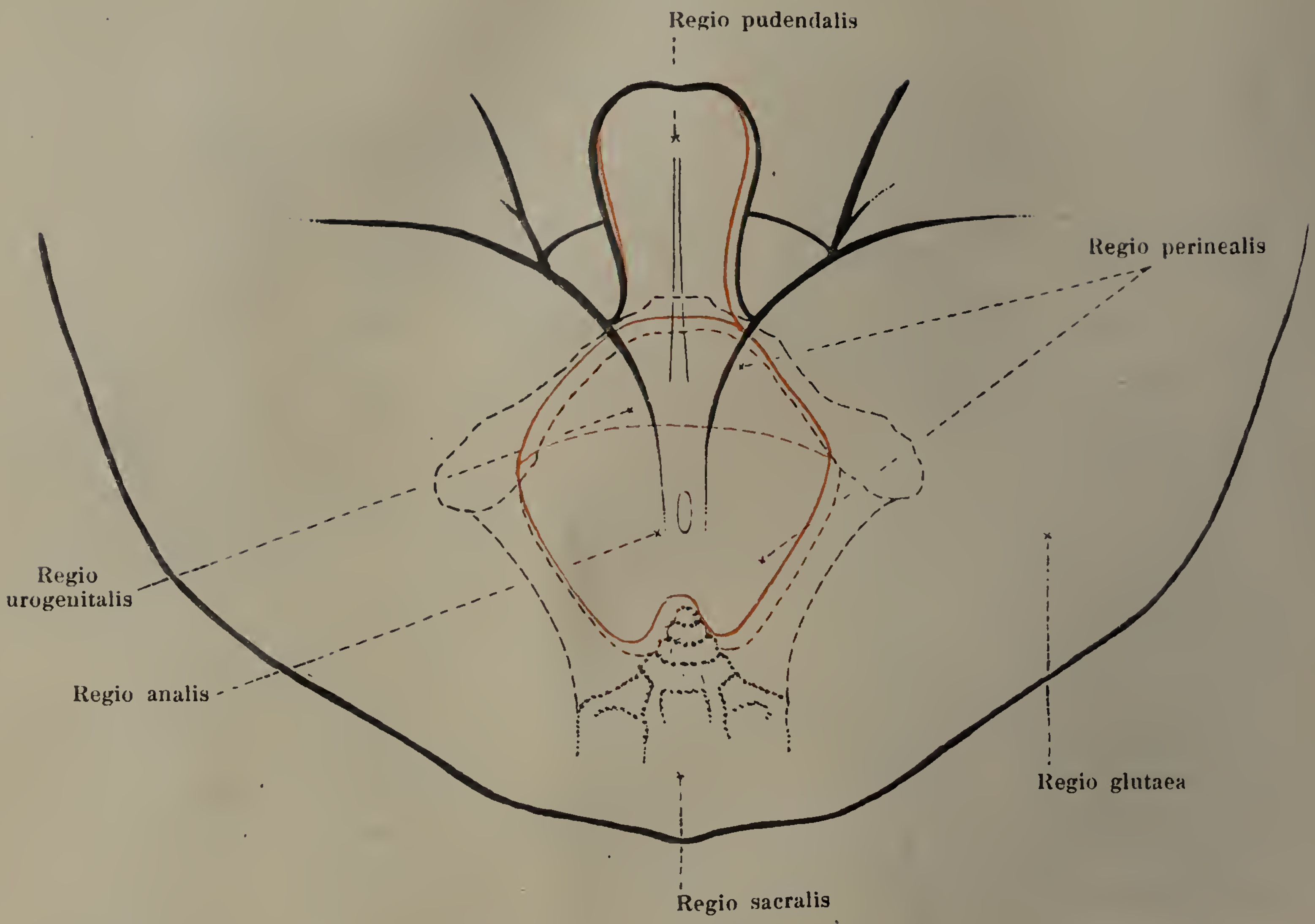
332. Regions of the head and neck.



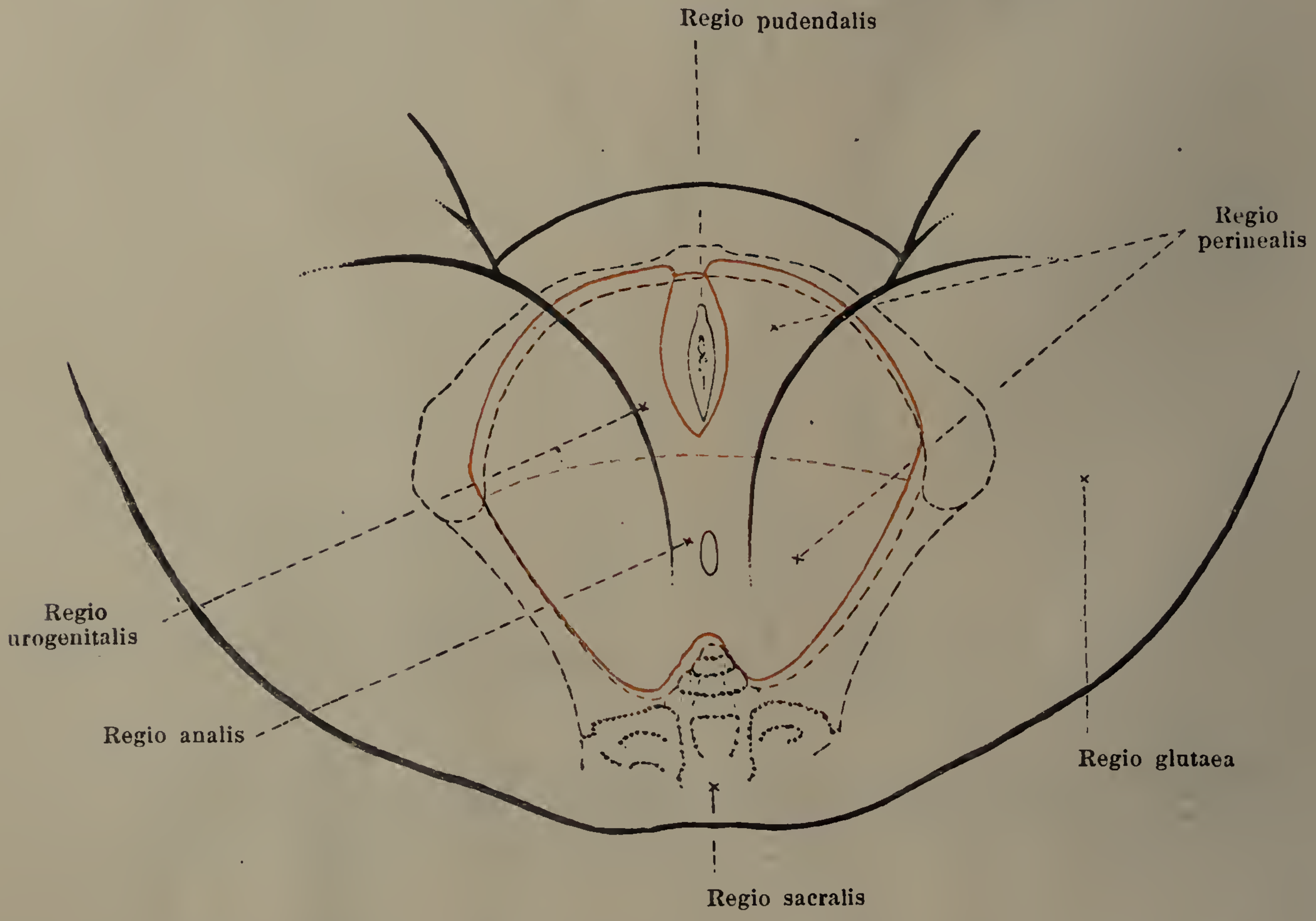
333. Regions of the body, viewed from in front.



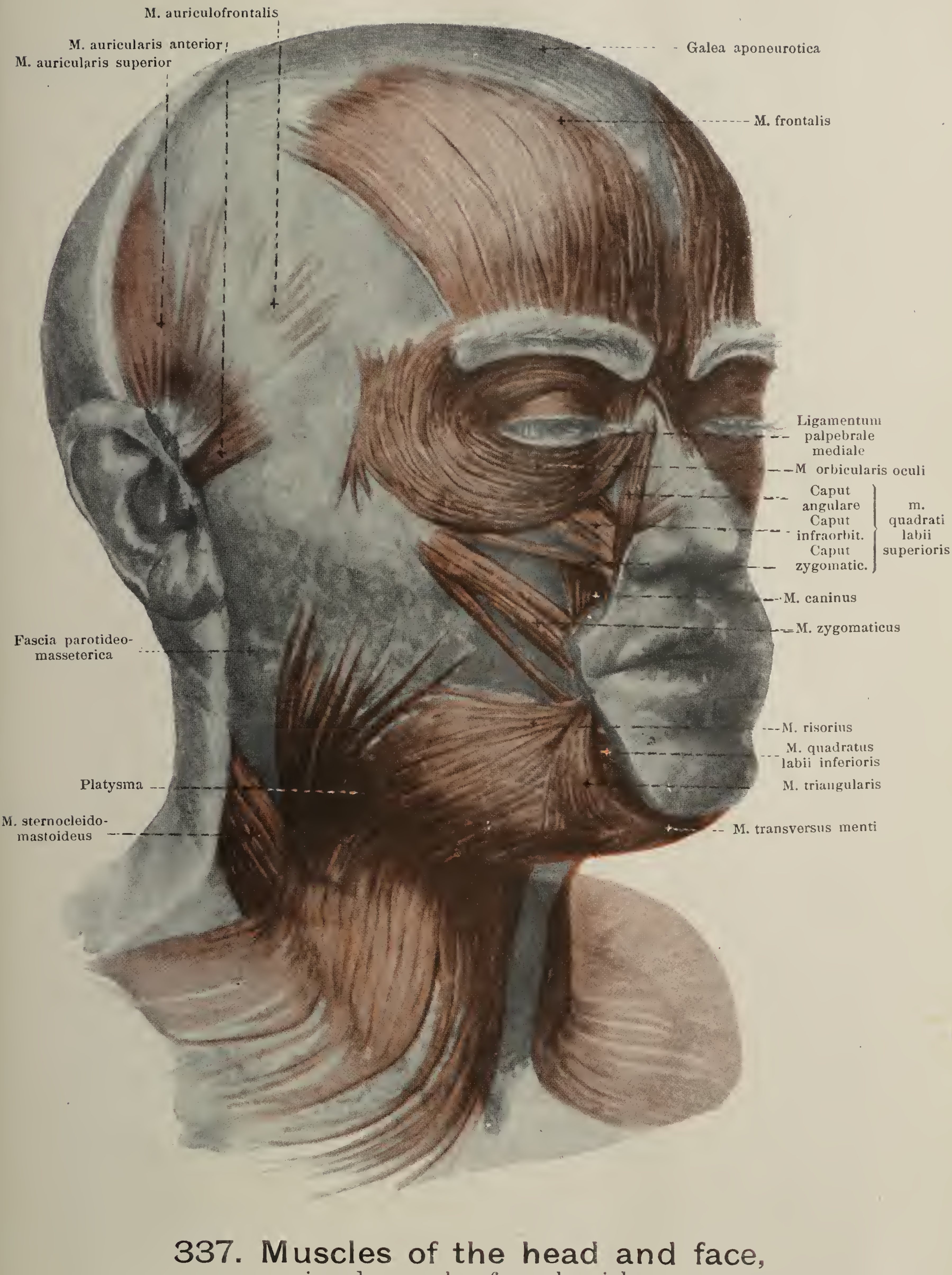
334. Regions of the body, viewed from behind.



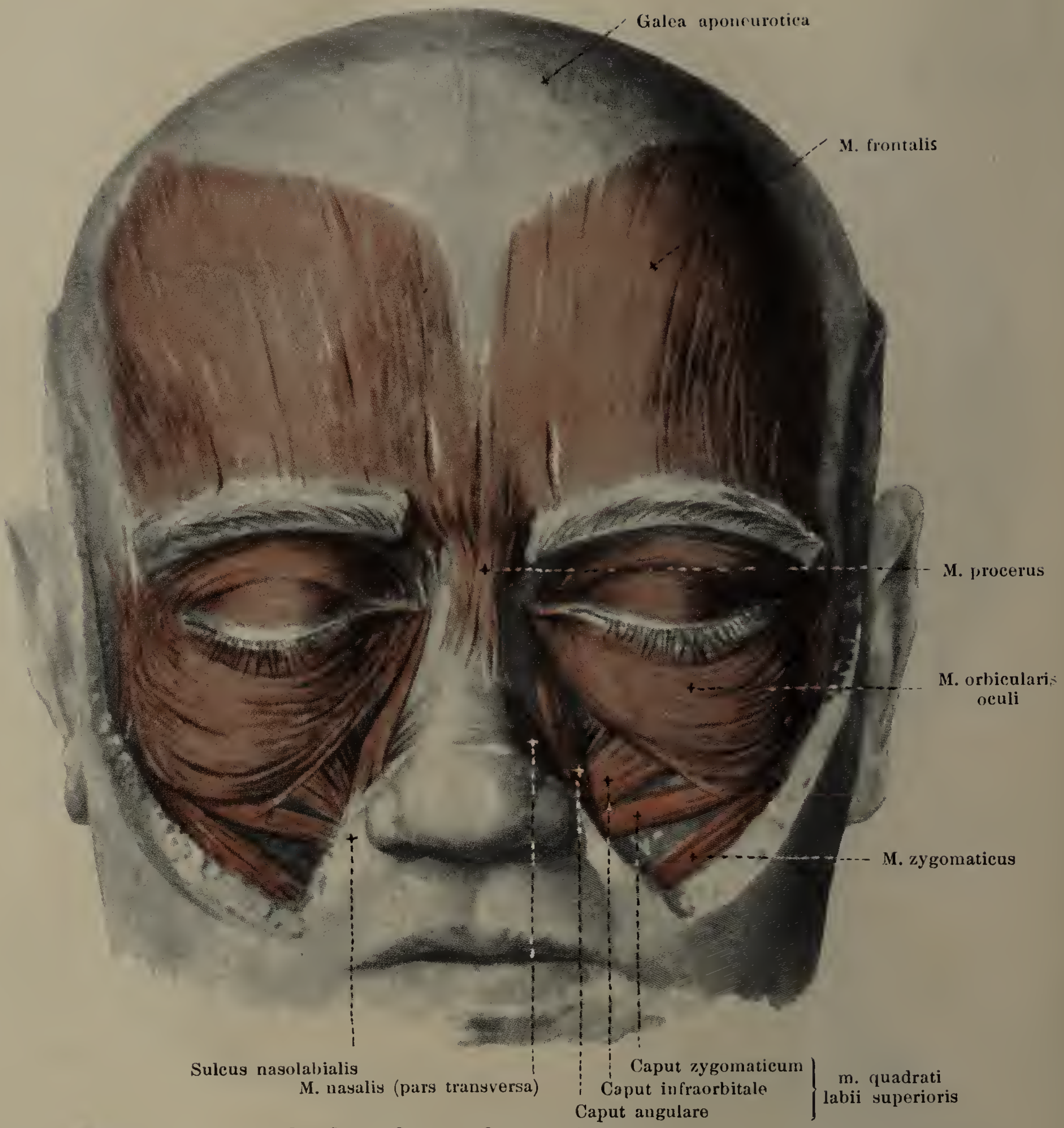
335. Regions of the male perineum.



336. Regions of the female perineum.



337. Muscles of the head and face,
viewed somewhat from the right.



338. Muscles of the head and face, viewed from in front.

Musculus epicranius. Form: flat, broad. Position: covers the roof of the skull.

Posterior part, fleshy: **mm. occipitales** (see Fig. 347). Origin: lineae nuchae supremae oss. occipitalis. Insertion: galea aponeurotica. Action: draw the galea backward.

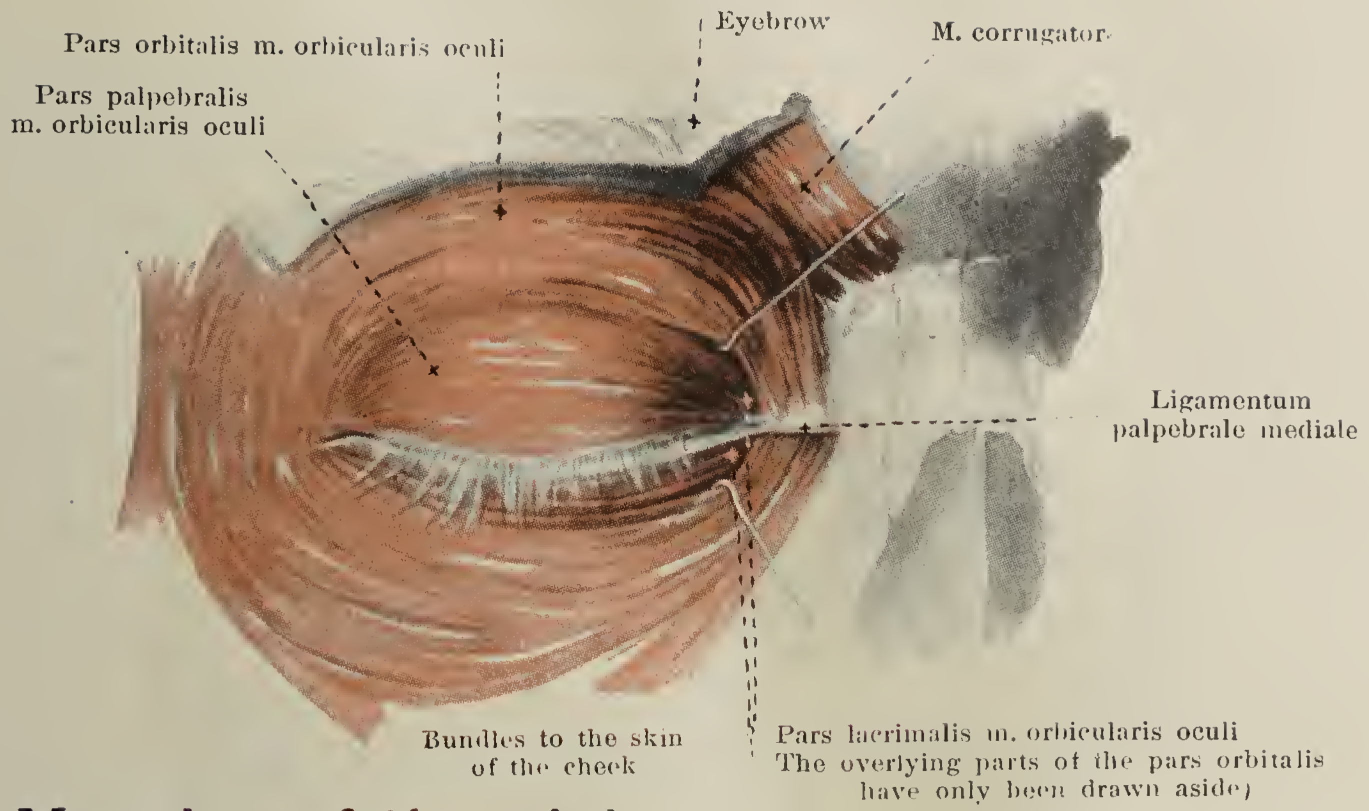
Middle portion, tendinous: **galea aponeurotica,** large, flat tendon, inserted between mm. occipitales and frontales; loosely and movably united with the periosteum, very firmly connected with the cutis.

Anterior portion, fleshy: **mm. frontales** (see also Fig. 337). Origin: galea aponeurotica. Insertion: skin of the eyebrows crossed by fibres of mm. orbiculares oculi. Action: draws eyebrows upward, wrinkles forehead transversely; move the galea aponeurotica.

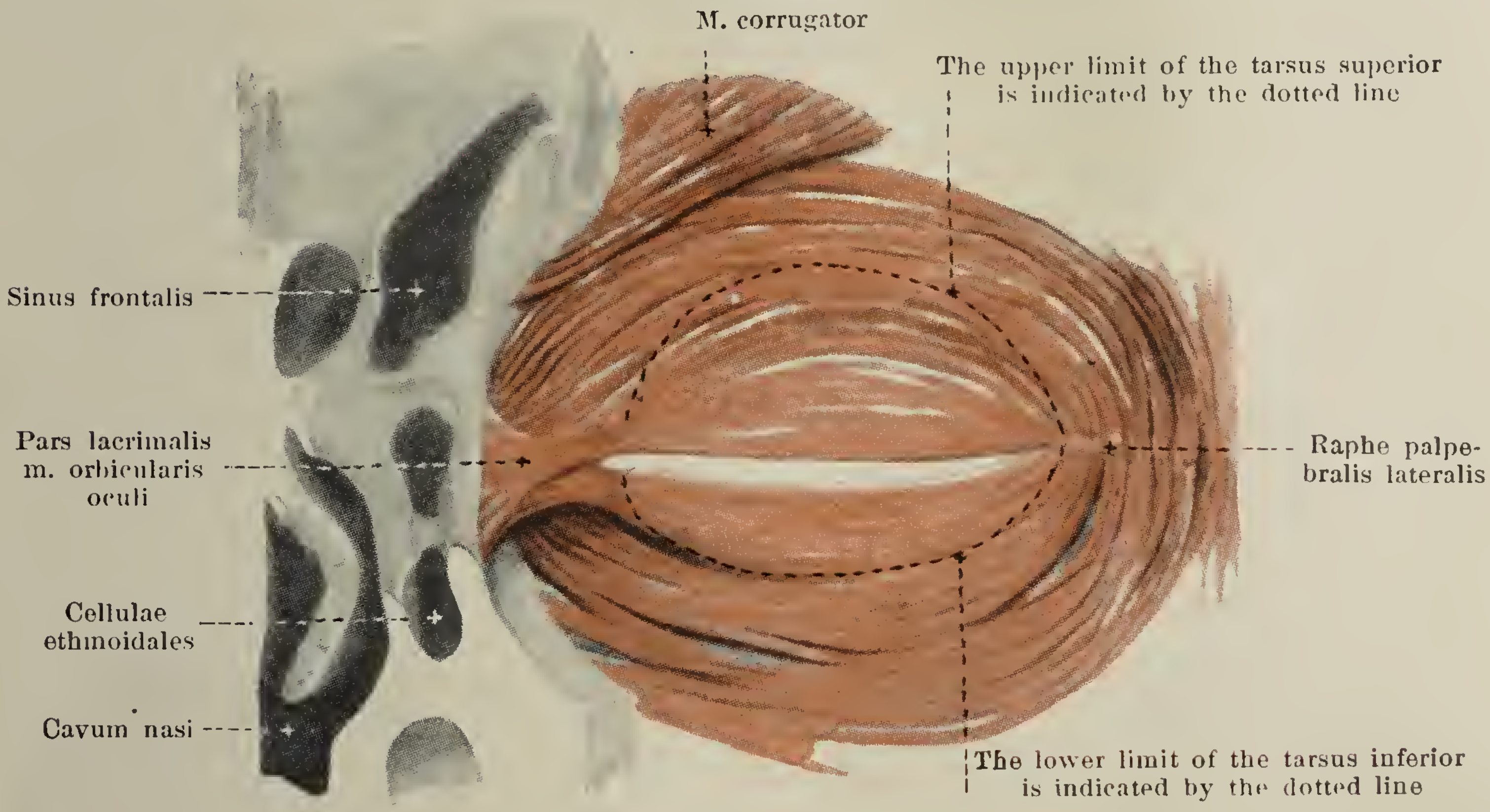
Innervation: nn. faciales.

M. procerus, unpaired. Origin: ossa nasalia. Insertion: skin between and above the eyebrows. Action: draws skin at the root of the nose downwards, causes transverse folds at the root of the nose. Innervation: nn. faciales.

M. quadratus labii superioris (see also Fig. 337). Form: flat, triangular. Position: lateral from the nose; origins partly covered by m. orbicularis oculi. *Caput angulare.* Origin: proc. frontalis and margo infraorbitalis maxillae. Insertion: skin of the ala nasi and of the sulcus nasolabialis. *Caput infraorbitale.* Origin: near under the margo infraorbitalis. Insertion: sulcus nasolabialis. *Caput zygomaticum.* Origin: facies malaris oss. zygomatici. Insertion: sulcus nasolabialis. Action: draws ala nasi upwards and upper lip upwards and outwards, widens nasal opening and deepens the sulcus nasolabialis. Innervation: n. facialis.

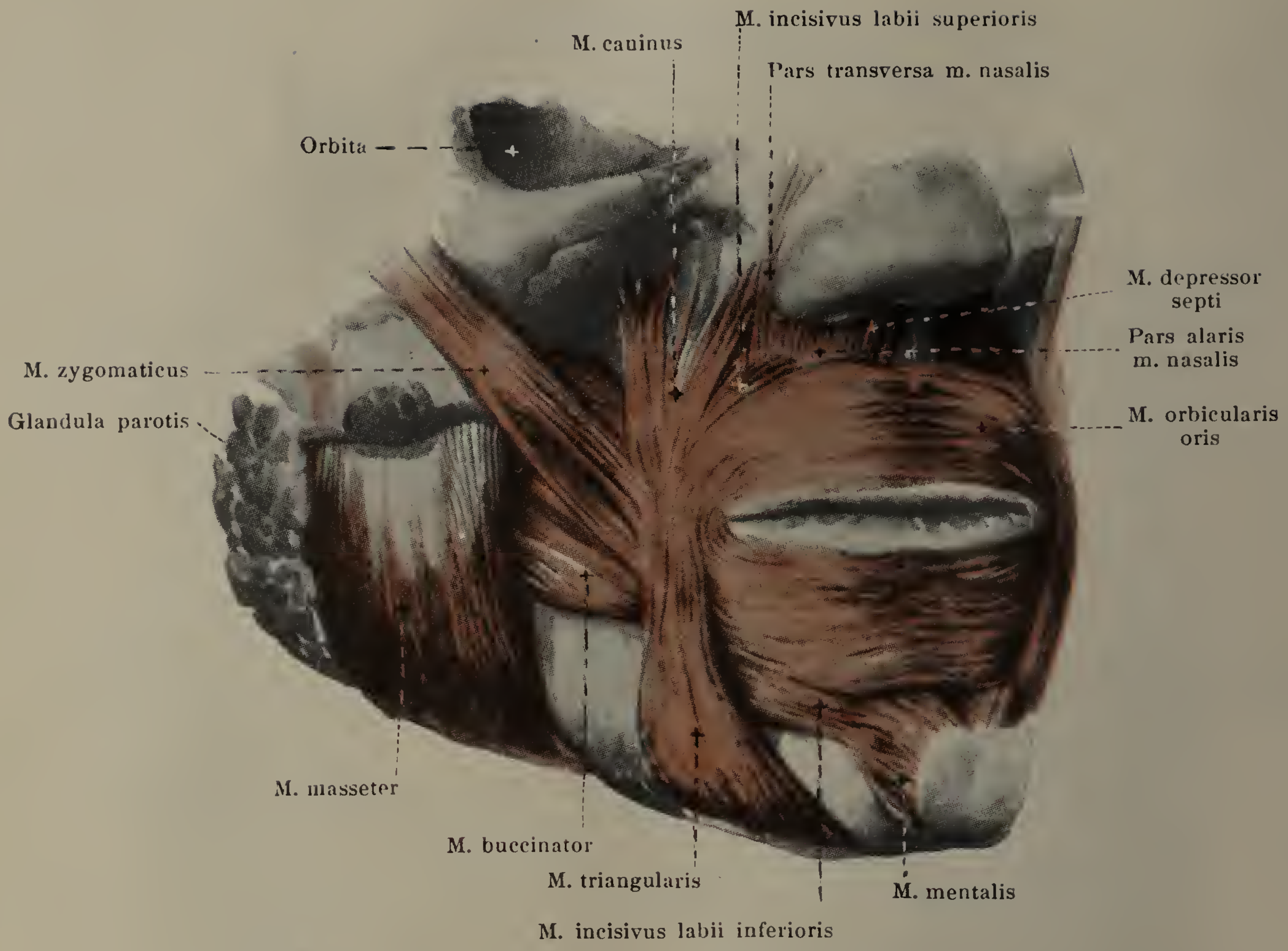

Pars orbitalis m. orbicularis oculi
Eyebrow
M. corrugator
Pars palpebralis m. orbicularis oculi
Ligamentum palpebrale mediale
Bundles to the skin of the cheek
Pars lacrimalis m. orbicularis oculi
(The overlying parts of the pars orbitalis have only been drawn aside)

339. Muscles of the right eyelid, viewed from in front.


M. corrugator
The upper limit of the tarsus superior is indicated by the dotted line
Sinus frontalis
Pars lacrimalis m. orbicularis oculi
Raphe palpebralis lateralis
Cellulae ethmoidales
Cavum nasi
The lower limit of the tarsus inferior is indicated by the dotted line

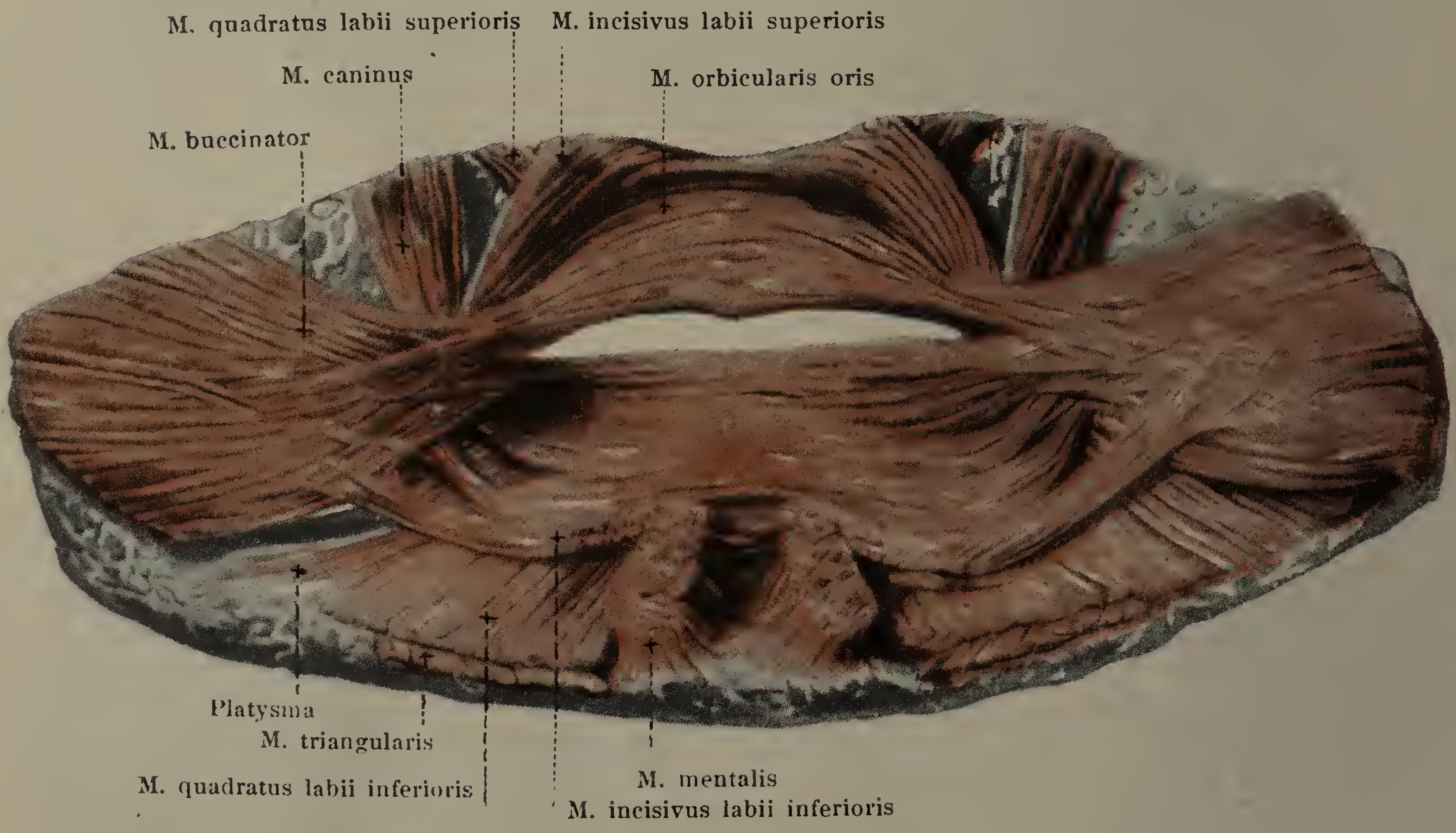
340. Muscles of the right eyelid, viewed from behind.

M. orbicularis oculi (see also Figs. 337 and 338). Form: flat, elliptical. Position: in the eyelids and at their periphery. *Pars orbitalis.* Origin: crista lacrimalis anterior maxillae, anterior limb of the lig. palpebrale mediale (upward and downward). The fibres of the upper medial portion run to the skin of the medial part of the eyebrow. The rest of the fibres surround the eyelids in flat, concentric arches, intercross above with the fibres of the m. frontalis and interweave with one another lateralward from the external angle of the eye. Fibres running in a vertical direction join up laterally, and below fibres which radiate from the medial and lateral part into the skin of the cheek. Action: draws the eyebrow medianward and downward, the skin of the cheek upward and medianward; helps to close the lids; forms radial folds in the skin of the lateral angle of the eye. *Pars lacrimalis [Horneri].* Origin: crista lacrimalis posterior oss. lacrimalis; it runs, partially crossed, behind the lig. palpebrale mediale and the tear-sac to the medial angle of the eye, spreads out thinly within the lids (corresponding in extent to about that of the tarsi) and go to a thin, horizontal band of connective tissue, ***raphe palpebralis lateralis*** (see also Figs. 925 and 929), which extends from the external angle of the eye to the lateral margin of the orbit (see p. 817). In the lids it forms the *pars palpebralis.* Action: widens tear-sac, closes eyelids. Innervation: n. facialis.



341. Muscles of the region of the mouth, viewed somewhat from the right side.

(Platysma, mm. risorius, quadrati and orbicularis oculi have been removed.)


M. quadratus labii superioris
M. incisivus labii superioris
M. caninus
M. orbicularis oris
M. buccinator
Platysma
M. triangularis
M. quadratus labii inferioris
M. mentalis
M. incisivus labii inferioris

342. Muscles of the region of the mouth, viewed from behind.

(The tissues about the mouth have been loosened from their bony subtratum and the muscles have been dissected out from the posterior surface.)

M. corrugator (see Figs. 339 and 340). Form: flat, narrow. Position: near the root of the nose. Origin: pars nasalis oss. frontalis. Insertion: extending lateralward and a trifle upward, skin over the middle of the eyebrow. Action: causes vertical folds at the side of the root of the nose. Innervation: n. facialis.

M. nasalis. Form: flat, triangular. Position: lateralward from and below the ala nasi, partly covered by the m. quadratus labii superioris. *Pars transversa.* Origin: jugum alveolare of the upper canine tooth, a few strands also in the skin at the furrow of the nasal ala. Insertion: to the dorsum of the nasal cartilage spreading out by a thin tendon to the muscle of the other side. *Pars alaris.* Origin: jugum alveolare of the upper lateral incisor tooth. Insertion: lateral and lower margin of the ala nasi. Action: draws ala nasi downward, narrows nasal opening. Innervation: n. facialis.

M. depressor septi. Form: flat, quadrangular. Position: below the nose, just medianward from the preceding muscle. Origin: jugum alveolare of the upper lateral incisor tooth. Insertion: septum mobile nasi and posterior part of the nostril. Action: draws the septum mobile downward, narrows nasal opening. Innervation: n. facialis.

M. risorius (see Fig. 337). Form: flat, triangular; very variable. Position: lateral from the angle of the mouth, upon the platysma. Origin: fascia parotideomasseterica. Insertion: unites at the angle of the mouth, or somewhat below it, with the m. triangularis. Action: helps to draw the angle of the mouth lateralward; causes dimple. Innervation: n. facialis.

M. zygomaticus (see also Fig. 337). Form: oblong, flat-cylindrical. Position: lateralward from and above the angle of the mouth, separated from caput zygomat. m. quadrati labii sup. by the v. facialis anterior. Origin: facies malaris oss. zygomatici. Insertion: skin of the angle of the mouth; a great deal of the fibres go over into the m. orbicularis oris. Action: draws the angle of the mouth lateralward and upward. Innervation: n. facialis.

M. caninus (see also Fig. 337). Form: flat, triangular. Position: in the fossa canina, covered by the m. quadratus labii superioris; comes to the surface between the latter and the m. zygomaticus. Origin: fossa canina Insertion: with converging fibres, partly to the skin of the angle of the mouth; partly the fibres go over arch-like into the lower lip. Action: draws the angle of the mouth upward; the muscles of the two sides together lift the lower lip and help to close the mouth. Innervation: n. facialis.

M. triangularis (see also Figs. 337 and 348). Form: flat, triangular. Position: below the angle of the mouth; covers the foramen mentale and partly the m. quadratus labii inferioris. Origin: just above the basis mandibulae below the foramen mentale. Insertion: with converging fibres to the angle of the mouth and, in largest part, arch-like into the upper lip. Single bundles sometimes connect the muscles of the two sides below the chin, upon the platysma, as the **m. transversus menti** (see Fig. 348). Action: draws the angle of the mouth downward; the muscles of the two sides together draw the upper lip down and help to close the mouth. Innervation: n. facialis.

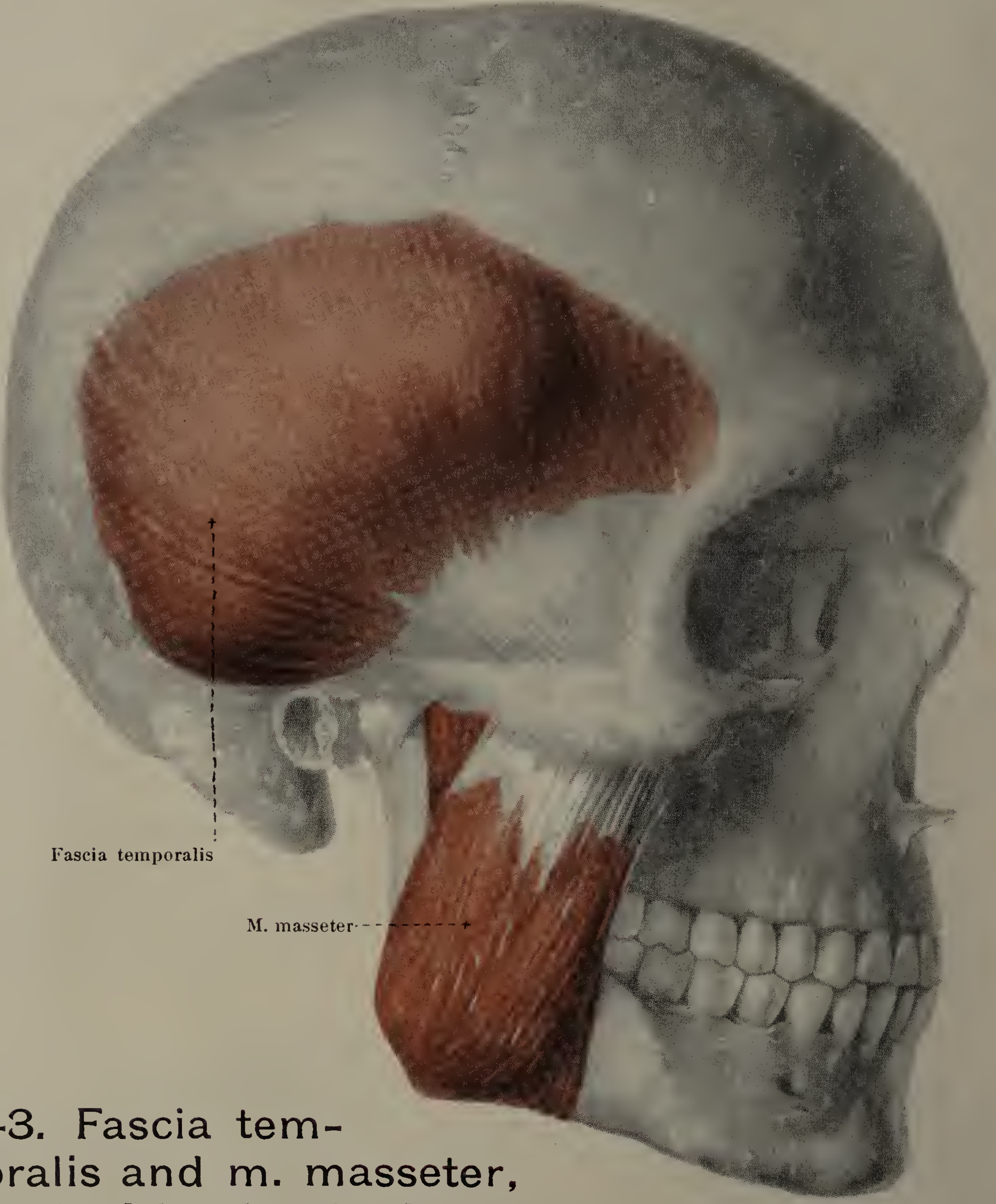
M. quadratus labii inferioris (see also Figs. 337 and 348). Form: flat, quadrangular. Position: below the lateral part of the mouth, for the most part covered by the m. triangularis; it covers the foramen mentale. Origin: the upper part is a direct continuation of the platysma, the lower part arises from the basis mandibulae. Insertion: skin of lower lip. Action: draws the lower lip lateralward and downward. Innervation: n. facialis.

M. incisivus labii superioris (see also Fig. 344). Form: flat, triangular, narrow. Position: above the angle of the mouth, covered by the m. quadratus labii superioris, medially of the m. caninus, at the upper margin of the m. orbicularis oris. Origin: jugum alveolare of the upper lateral incisor tooth. Insertion: arch-like to the angle of the mouth, interwoven there with the other muscles. Action: draws the angle of the mouth medianward and upward. Innervation: n. facialis.

M. incisivus labii inferioris (see also Fig. 344). Form: flat, quadrangular, narrow. Position: below the angle of the mouth, covered by the m. quadratus labii inferioris, laterally of the m. mentalis, at the lower margin of the m. orbicularis oris. Origin: jugum alveolare of the lower canine tooth, connecting with the m. mentalis. Insertion: to the lower margin of the m. orbicularis oris, interweaving with it. Action: draws the angle of the mouth medianward and a trifle downward. Innervation: n. facialis.

M. orbicularis oris, a muscle-plate situated in the lips which owes its formation to the fact that the muscles going to the mouth opening, at the angles of the mouth, completely or partly radiate out into the upper or lower lip. The fibres run in the lips partly intercrossing, for the most part transversely, at the angles of the mouth arch-like between the two lips and are attached in part to the external skin and to the mucous membrane. In this way a sort of ring muscle is formed. Action: if the latter contracts alone it closes the mouth and points it. Innervation: nn. faciales.

M. mentalis. Form: thick, cylindrical, short. Position: on the chin. Origin: jugum alveolare of the lower medial incisor tooth. Insertion: with diverging bundles in front and obliquely downward into the skin of the chin, interweaving there partly with fibres of the other side. Action: lifts the skin of the chin and wrinkles it. Innervation: n. facialis.



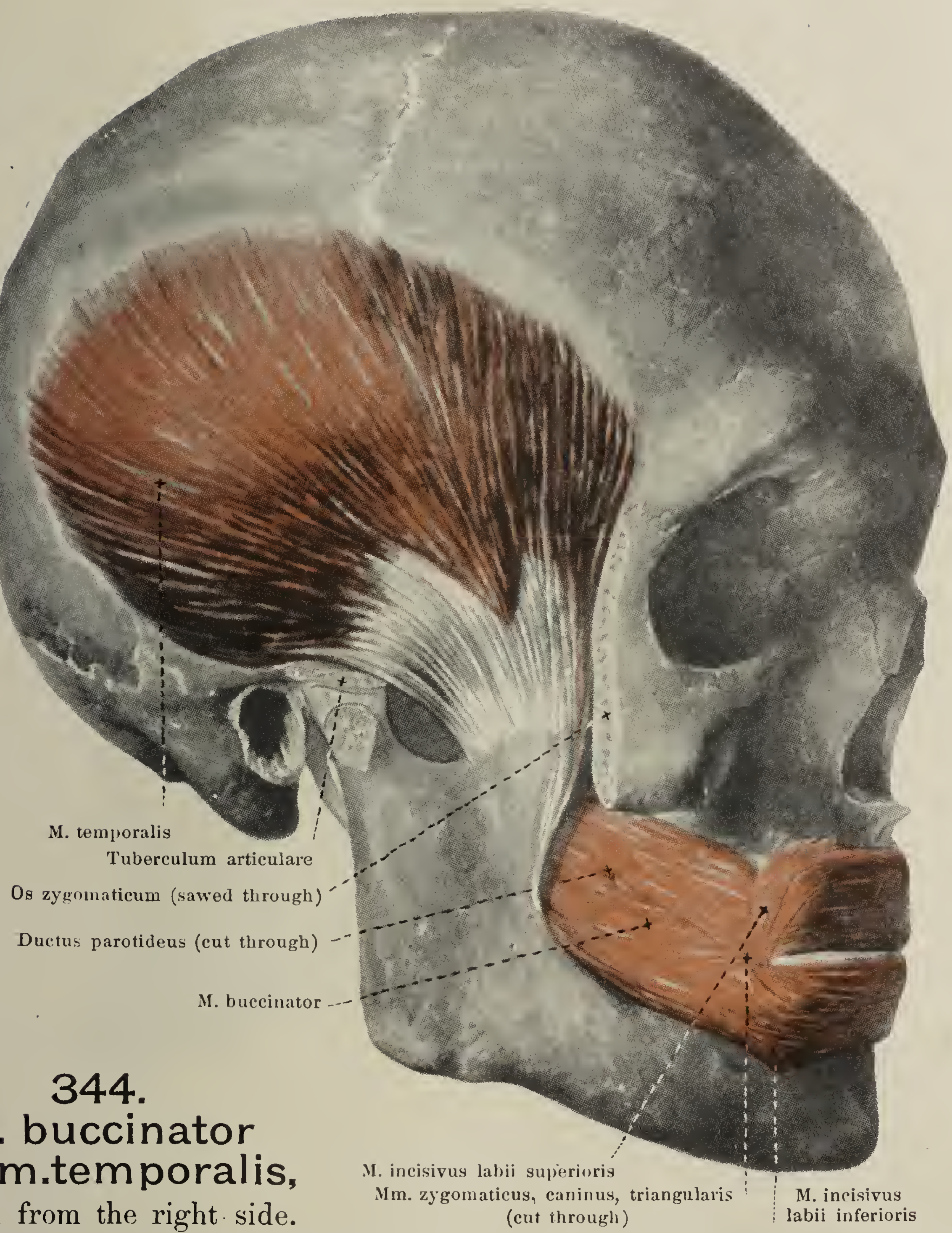
343. Fascia temporalis and m. masseter,

viewed from the right side.

Fascia parotideomasseterica (see Fig. 337) covers the lateral (and medial) surface of the glandula parotis as a thick membrane, the m. masseter as a thinner membrane, and becomes lost medianward below the m. zygomaticus, platysma and m. risorius.

Fascia temporalis, very dense, covers the fossa temporalis externally, arises from the linea temporalis superior, divides below into two layers, is separated usually by fat from the m. temporalis and goes to the medial and lateral surface of the arcus zygomaticus and the os zygomaticum.

M. masseter. Form: flat, quadrangular, thick. Position: immediately upon the lateral surface of the ramus mandibulae; behind partly covered over by the glandula parotis, in front and below by the platysma. It consists of two layers which are separated from one another distinctly behind only; the external layer is the longer and broader. Origin: external layer: anterior and middle part of the arcus zygomaticus (tendon of origin jagged, reaching far downward); internal layer: middle and posterior part of the arcus zygomaticus; both layers also from its inner surface. Insertion: external layer (multipinnate): obliquely backward and downward to the lateral surface of the angulus mandibulae and its periphery; internal layer: downward and somewhat forward to the lateral surface of the ramus mandibulae. Action: lifts the lower jaw. Innervation: n. massetericus (V. 3).

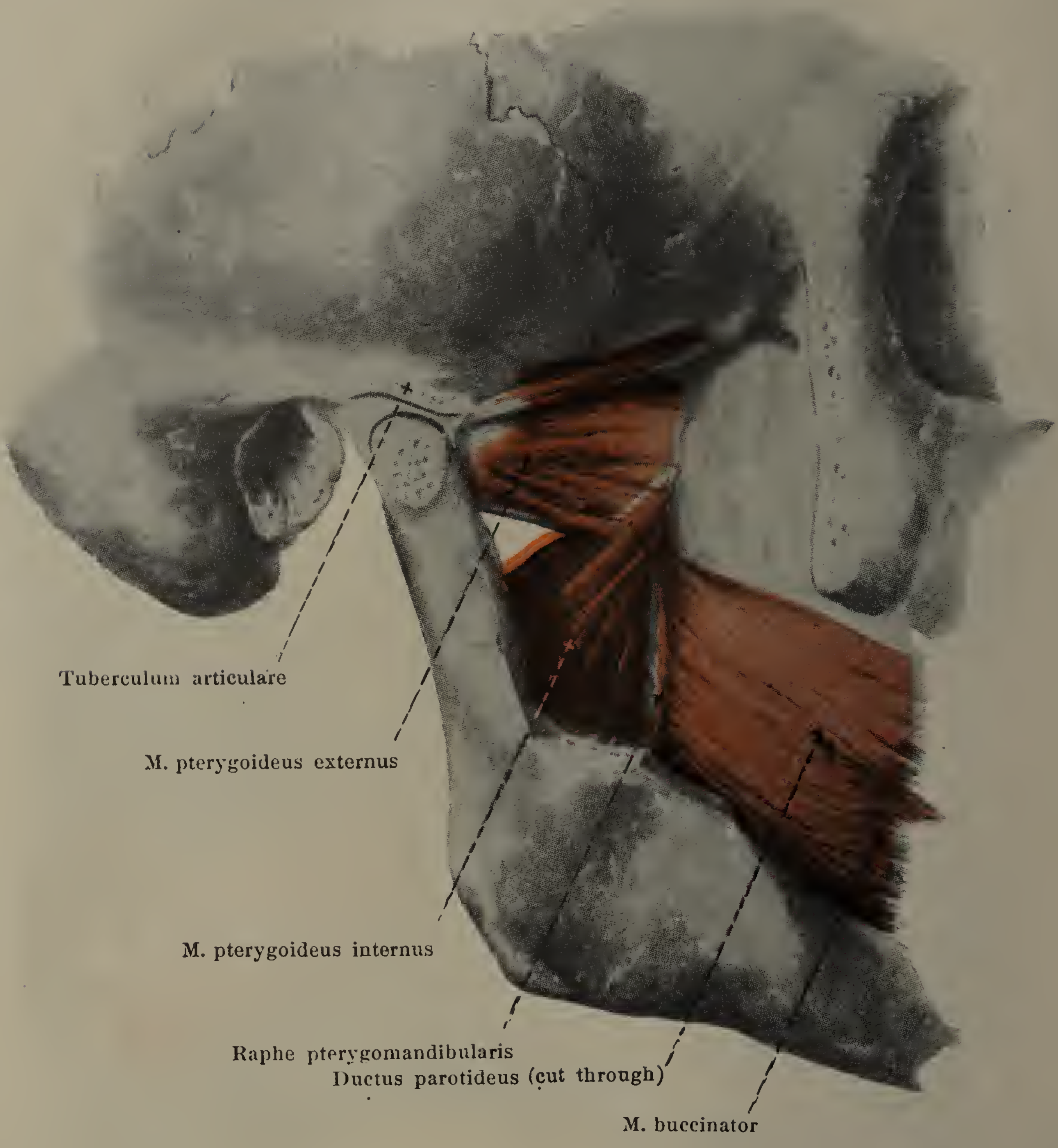

M. temporalis
Tuberculum articulare
Os zygomaticum (sawed through)
Ductus parotideus (cut through)
M. buccinator
M. incisivus labii superioris
Mm. zygomaticus, caninus, triangularis
(cut through)
M. incisivus
labii inferioris

344.
M. buccinator and m.temporalis,
viewed from the right side.

(The arcus zygomaticus has been sawed away at its origins, the joint of the lower jaw having been opened at the same time. An outer layer of the m. temporalis is cut off.)

M. temporalis. Form: flat, triangular, broad and thin above, narrow and thick below, bipinnate. Position: covered by the fascia temporalis and the arcus zygomaticus; it fills up the fossa temporalis completely. Origin: nearly the whole extent of the fossa temporalis and medial surface of the fascia temporalis and (a few strands) the arcus zygomaticus. Insertion: the anterior fibres run vertically, the posterior at first almost horizontally, than markedly curved; all the fibres converge to the processus coronoideus mandibulae and descend deep on its medial surface. The tendon reaches inside in a jagged form as far as half the height of the muscle. Action: lifts the lower jaw and draws the processus coronoideus and thus also the processus condyloideus somewhat backward. Innervation: nn. temporales profundi (V. 3).

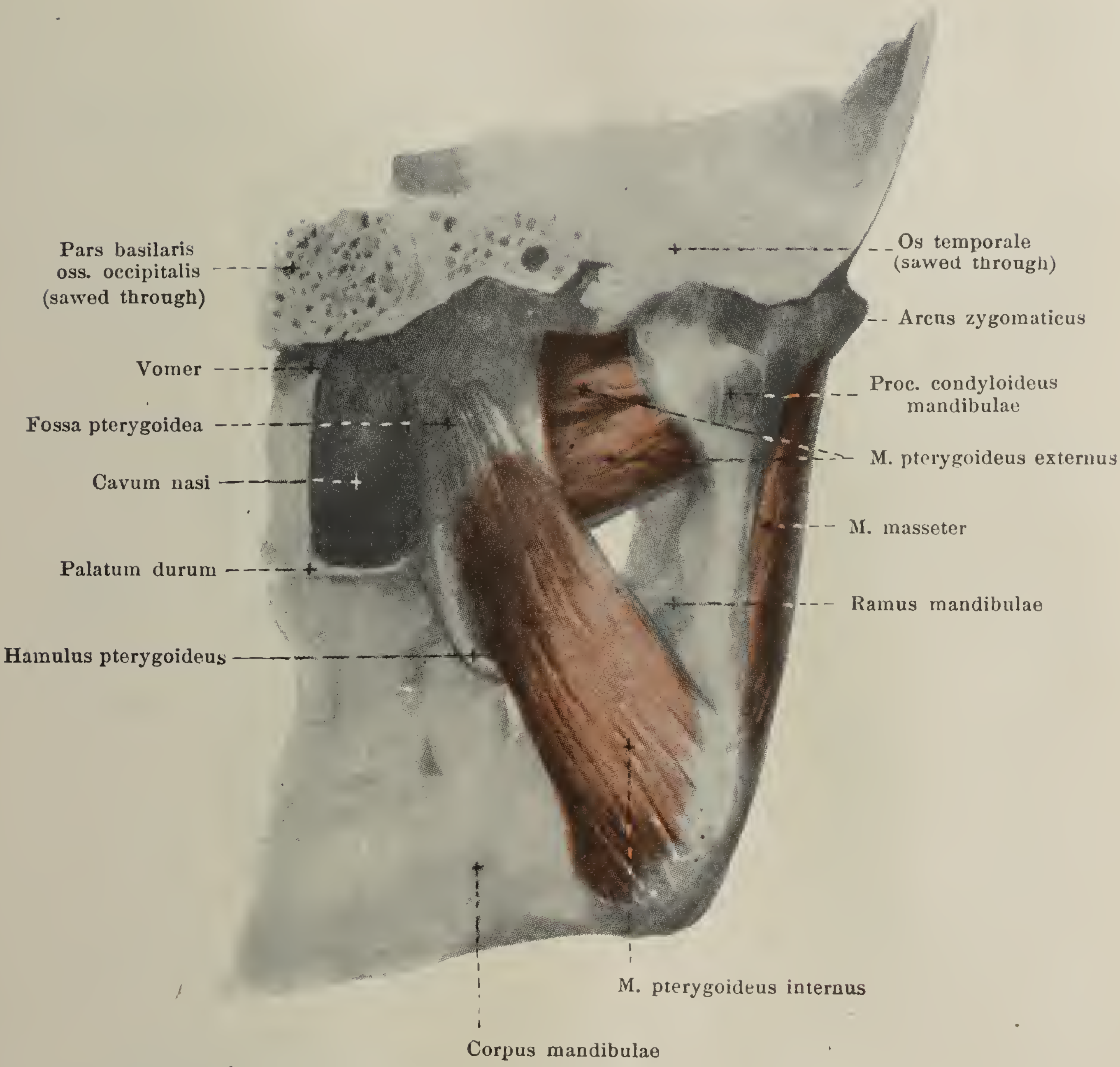
Fascia buccopharyngea, very thin, covers the lateral surface of the m. buccinator; it becomes lost in front at the angle of the mouth, is stretched out as a denser cord between the hamulus pterygoideus and the posterior end of the crista buccinatoria [mandibulae] as the *raphe pterygomandibularis* (see Fig. 345) and goes over behind upon the outer surface of the muscles of the throat.



345. Mm. pterygoidei of the right side, external view.

(The arcus zygomaticus has been removed as in Fig. 344; the processus coronoideus and an adjacent piece of bone have been chiselled out of the ramus mandibulae.)

M. buccinator (see also Figs. 341, 342 and 344). Form: flat, oblong-quadrangular, thin. Position: beneath all the other muscles of the mouth like a transverse, curved band, close to the mucous membrane of the cheeks and lips, along the rows of teeth. Origin: raphe pterygomandibularis (see p. 265), lateral surface of the processus alveolaris maxillae and crista buccinatoria (or corresponding portion) of the lower jaw bone. The fibres run partly parallel, partly they decussate into the upper and lower lip at the angles of the mouth and there go over into the fibres of the muscles of the other side. Part of the fibres are attached laterally of the angle of the mouth to the mucous membrane. In the lips it forms the deepest layer of the m. orbicularis oris. In the region of the crown of the second (or first) upper molar it is pierced by the ductus parotideus. Action: it draws the angle of the mouth lateralward, closes the mouth opening, presses the lips and cheeks upon the teeth. Innervation: n. facialis.



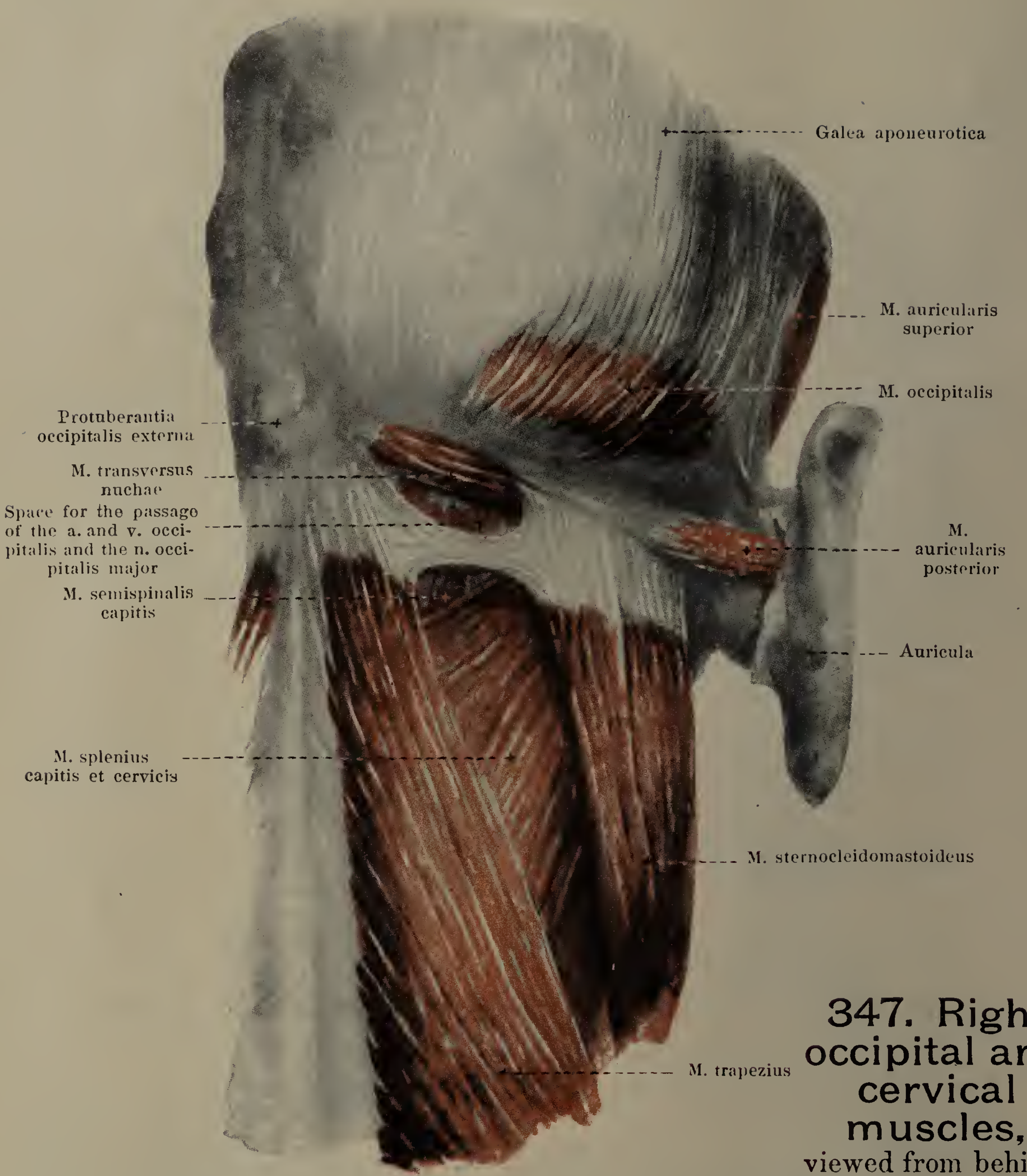
346. Muscles of mastication on right side,

viewed from behind and somewhat medianward.

(The posterior half of the skull has been removed.)

M. pterygoideus externus (see also Fig. 345). Form: triangular, thick, inferior head bipinnate. Position: in the fossa infratemporalis, covered lateralward by the m. temporalis, arcus zygomaticus and m. masseter. Origin: by two heads; *upper* and lesser *head:* flat, from the crista infratemporalis and the facies infratemporalis of the great wing of the sphenoid; *lower head:* rounded, partly from the lateral surface of the lamina lateralis proc. pterygoidei and from the processus pyramidalis oss. palatini, partly from the facies infratemporalis maxillae. Insertion: the fibres run converging backward and lateralward to the fovea pterygoidea proc. condyloidei mandibulae, the fibres of the upper head partly also to the anterior surface of the capsula articularis and of the discus articularis of the joint of the lower jaw. Action: draws the mandibula forward, the proc. condyloideus and discus articularis under the tuberculum articulare; when it acts on one side alone, it draws the jaw somewhat toward the other half of the body. Innervation: n. pterygoideus externus (V. 3).

M. pterygoideus internus (see also Fig. 345). Form: oblong-quadrangular, thick. Position: on the medial side of the lower jaw, in a direction similar to that of the m. masseter; it is covered lateralward partly by the m. pterygoideus externus, m. temporalis, ramus mandibulae and m. masseter. Origin: tendinously fossa pterygoidea, by a small part also (lateralward from the m. pterygoideus externus) from proc. pyramidalis oss. palatini and facies infratemporalis maxillae. Insertion: by parallel fibres downward, backward and somewhat lateralward to the medial surface of the angulus mandibulae and its neighborhood. Action: lifts the lower jaw; when it acts on one side only, it draws the jaw toward the opposite side of the body. Innervation: n. pterygoideus internus (V. 3).


Galea aponeurotica
M. auricularis superior
M. occipitalis
Protuberantia occipitalis externa
M. transversus nuchae
Space for the passage of the a. and v. occipitalis and the n. occipitalis major
M. auricularis posterior
M. semispinalis capitis
Auricula
M. splenius capitis et cervicis
M. sternocleidomastoideus
M. trapezius

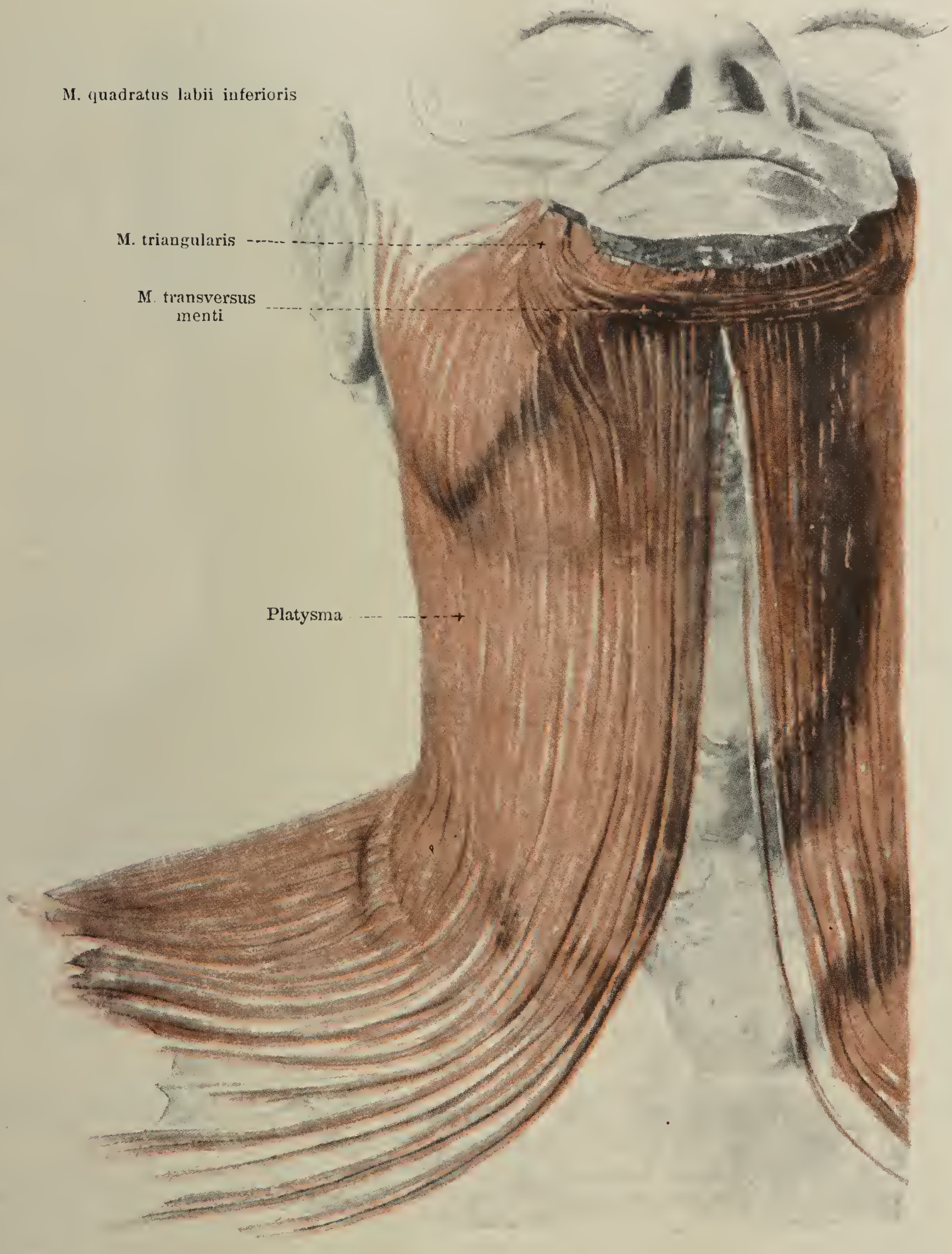
347. Right occipital and cervical muscles, viewed from behind.

M. auricularis anterior (O. T. attrahens aurem) (see Figs. 337 and 929). Form: flat, triangular. Position: in front of and above the ear. Origin: galea aponeurotica. Insertion: spina helicis auriculare. Action: it draws the auricle forward and upward. Innervation: n. facialis.

M. auricularis superior (O. T. attollens aurem) (see also Figs. 337 and 929). Form: flat, triangular. Position: above the ear. Origin: galea aponeurotica. Insertion: narrow, to the eminentia fossae triangularis auriculae. Action: it draws the auricle upward. Innervation: n. facialis.

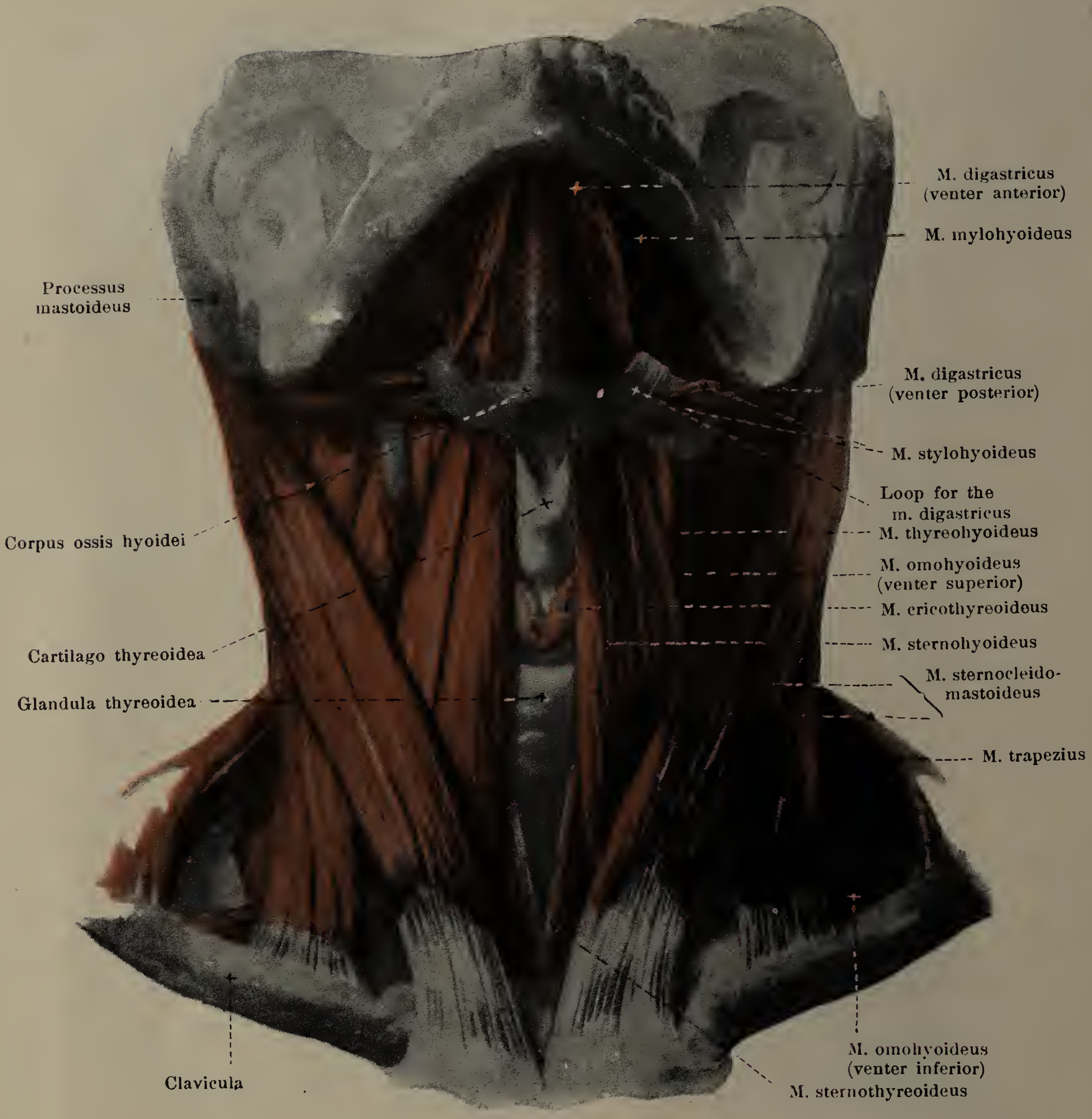
M. auricularis posterior (O. T. retrahens aurem) (see also Fig. 929). Form: oblong-quadrangular, single or divided. Position: behind the ear. Origin: pars mastoidea oss. temporalis, upon the tendon of the m. sternocleidomastoideus. Insertion: with parallel fibres to the eminentia conchae auriculae. Action: it draws the auricle backward. Innervation: n. auricularis posterior (VII).

M. transversus nuchae, inconstant. Form: oblong-quadrangular. Position: it lies superficially upon the linea nuchae superior, in the same layer as the mm. trapezius and sternocleidomastoideus. Origin: protuberantia occipitalis externa. Insertion: tendon of the m. sternocleidomastoideus. Innervation: n. auricularis posterior (VII).



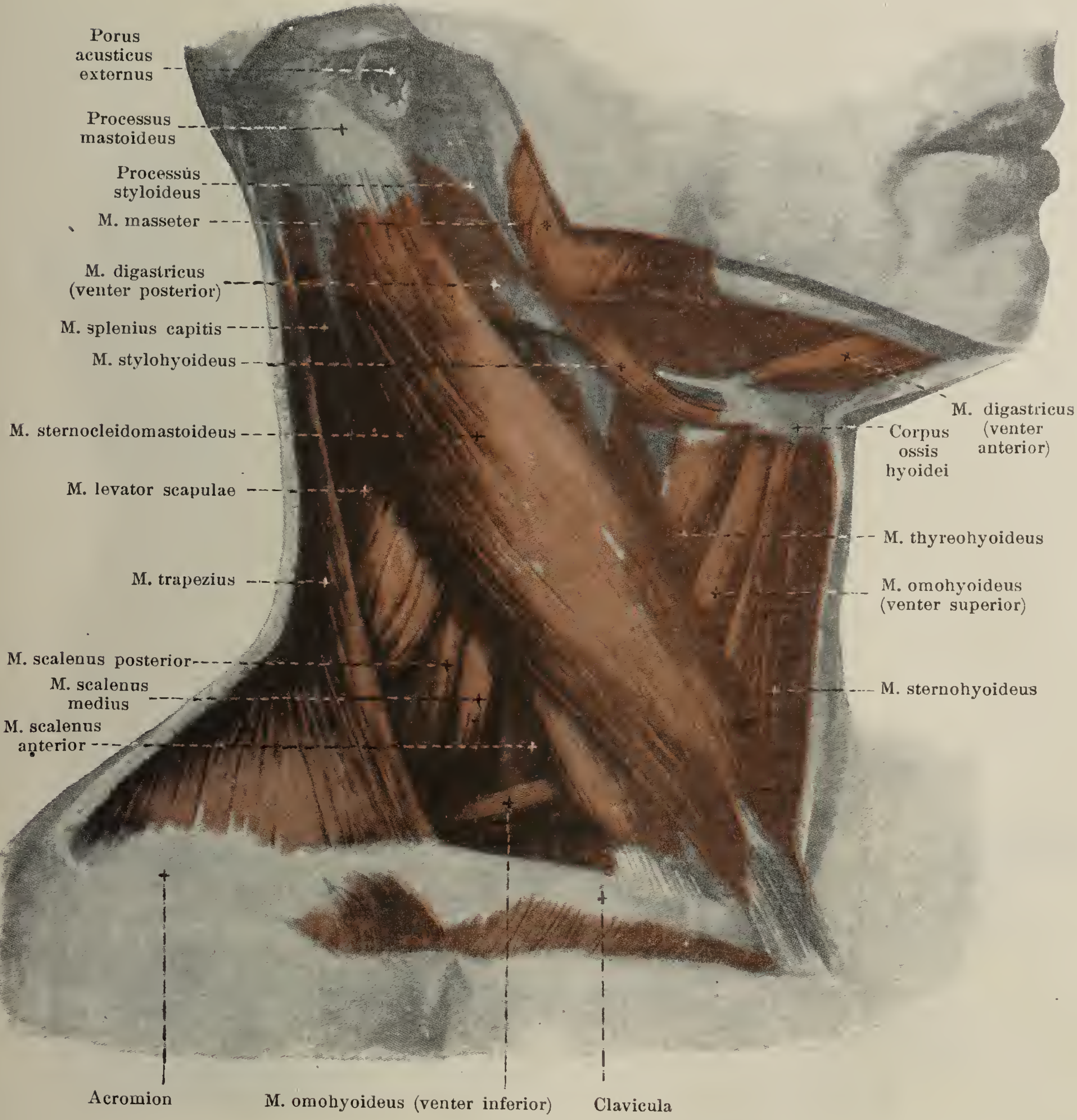
348. **Right platysma,** viewed from in front.

Platysma (see also Figs. 337 and 342). Form: oblong-quadrangular, thin, very large. Position: just beneath the skin in the clavicular region, in the neck and in the lower part of the face. Origin: fascia pectoralis in region of breast and shoulder. Insertion: the fibres run parallel, medianward and upward; the posterior fibres radiate out upon the fascia parotideomasseterica, the anterior go partly to the angle of the mouth, partly into the m. quadratus labii inferioris, partly (from the region of the first molar tooth till to the median plane) to the basis mandibulae. Below the chin the fibres of the two sides often decussate. Action: it lifts the skin of the neck from the subjacent tissue; it draws the angle of the mouth to the side and downward. Innervation: ramus colli n. facialis.



349. Muscles of the neck (2nd layer), viewed from in front.
(The head has been bent backward; the platysma has been removed.)

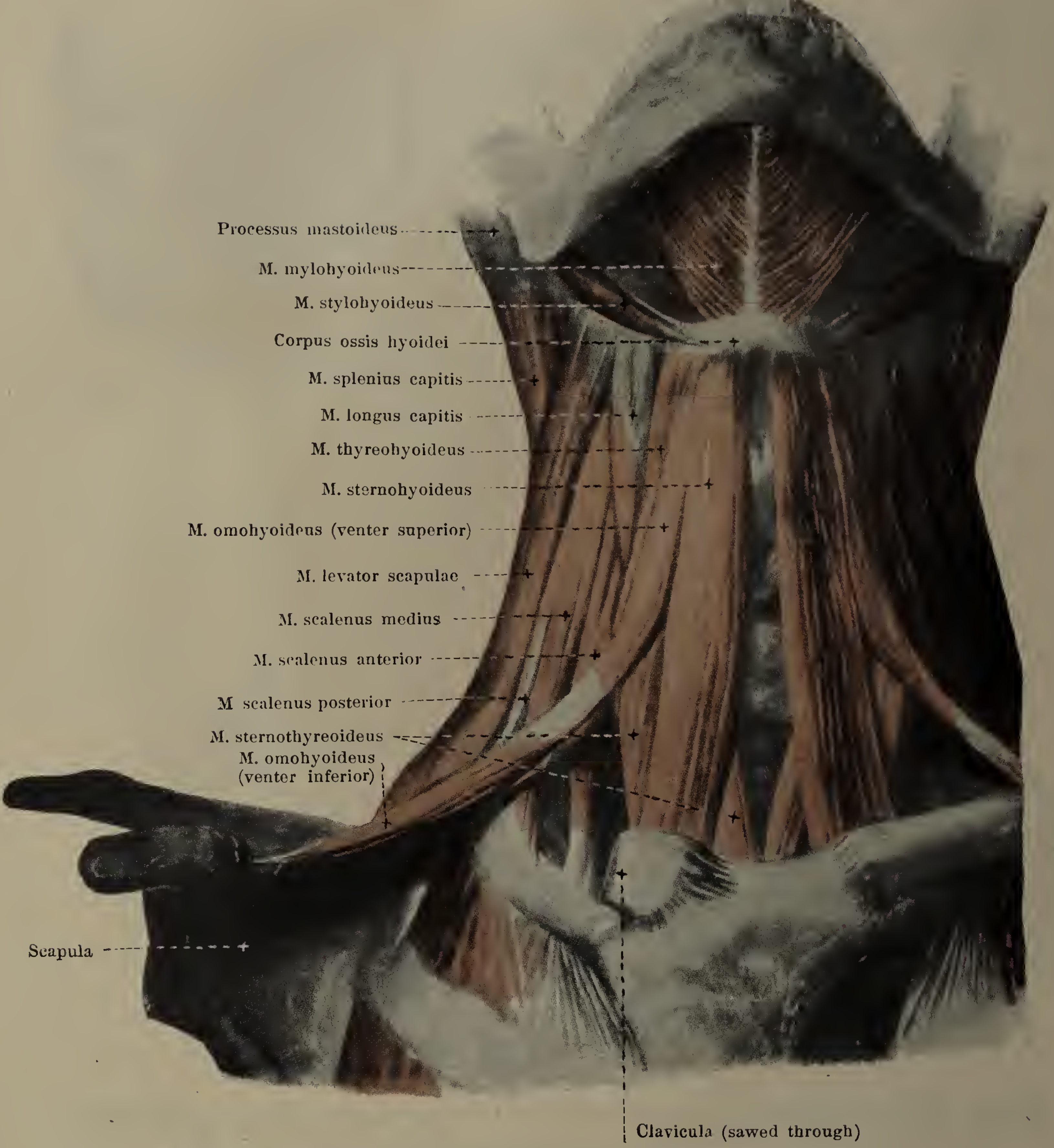
M. sternocleidomastoideus (see also Figs. 347 and 350). Form: long, flat-cylindrical, strong. Position: on the lateral and anterior surface of the neck, covered in its lower half by the platysma. Origin: by two heads; *medial head:* by a long tendon from the anterior surface of the manubrium sterni, partly covering the articulatio sternoclavicularis; *lateral head:* by a short tendon from the upper surface of the sternal extremity of the clavicle. Between the two heads there is usually a triangular space, which is broader below, and to which corresponds the fossa supraclavicularis minor (see Fig. 332). Insertion: the lateral head runs a little steeper and passes under the medial; the two unite at about the middle of the neck and go obliquely upward, backward and lateralward to become attached by a short tendon to the lateral surface of the processus mastoideus and to the linea nuchae suprema. Action: the muscle of one side acting alone turns the head to the opposite side and the face at the same time upward; the muscles of both sides acting together lift the face a little and draw the head a trifle forward, or, if the head be fixed, they elevate the clavicle (in the articulatio sternoclavicularis) and the sternum (and with them also the thorax). Innervation: n. accessorius and a branch of the n. occipitalis minor (C_2).



350. Muscles of the neck (2nd layer), viewed from the right side.
(The platysma has been removed.)

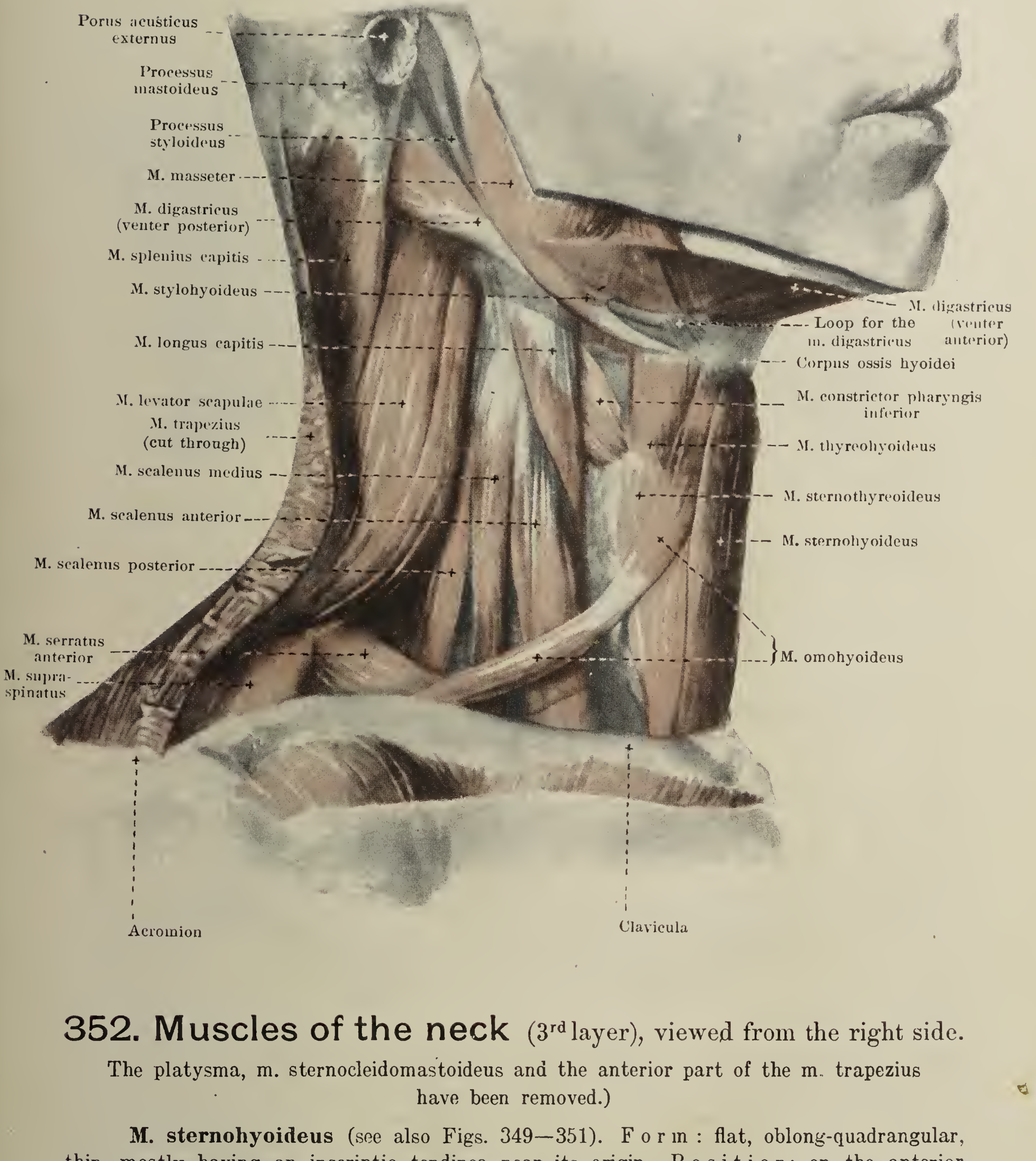
M. digastricus (see also Figs. 349, 352 and 568). Form: two rounded bellies, *venter posterior* and *venter anterior*, with a long intermediate tendon. Position: below, behind and medianward from the mandibula, covered behind by the glandula parotis, in front partly by the glandula submaxillaris. The *venter posterior* (bipinnate) arises in the incisura mastoidea oss. temporalis and goes over in front and below into an intermediate tendon, which is fastened by a loop-like strip of the fascia colli to the corpus oss. hyoidei; the *venter anterior* arises from this intermediate tendon and usually also from the corpus oss. hyoidei and goes to the fossa digastrica mandibulae. Action: when the hyoid bone is fixed, it depresses the lower jaw; when the lower jaw is fixed, it draws the hyoid bone upward. Innervation: *venter posterior:* r. digastricus n. facialis; *venter anterior:* n. mylohyoideus (V. 3).

M. stylohyoideus (see also Figs. 349, 351 and 352). Form: flat, oblong, thin. Position: behind and below the mandibula, just in front of and above the posterior belly of the m. digastricus (vide supra). Origin: processus styloideus. Insertion: forward, downward and medianward to the corpus oss. hyoidei; in the neighborhood of its insertion it surrounds the m. digastricus by two limbs, a lateral, stronger and a medial, feebler. Action: it draws the hyoid bone backward and upward. Innervation: r. stylohyoideus n. facialis.



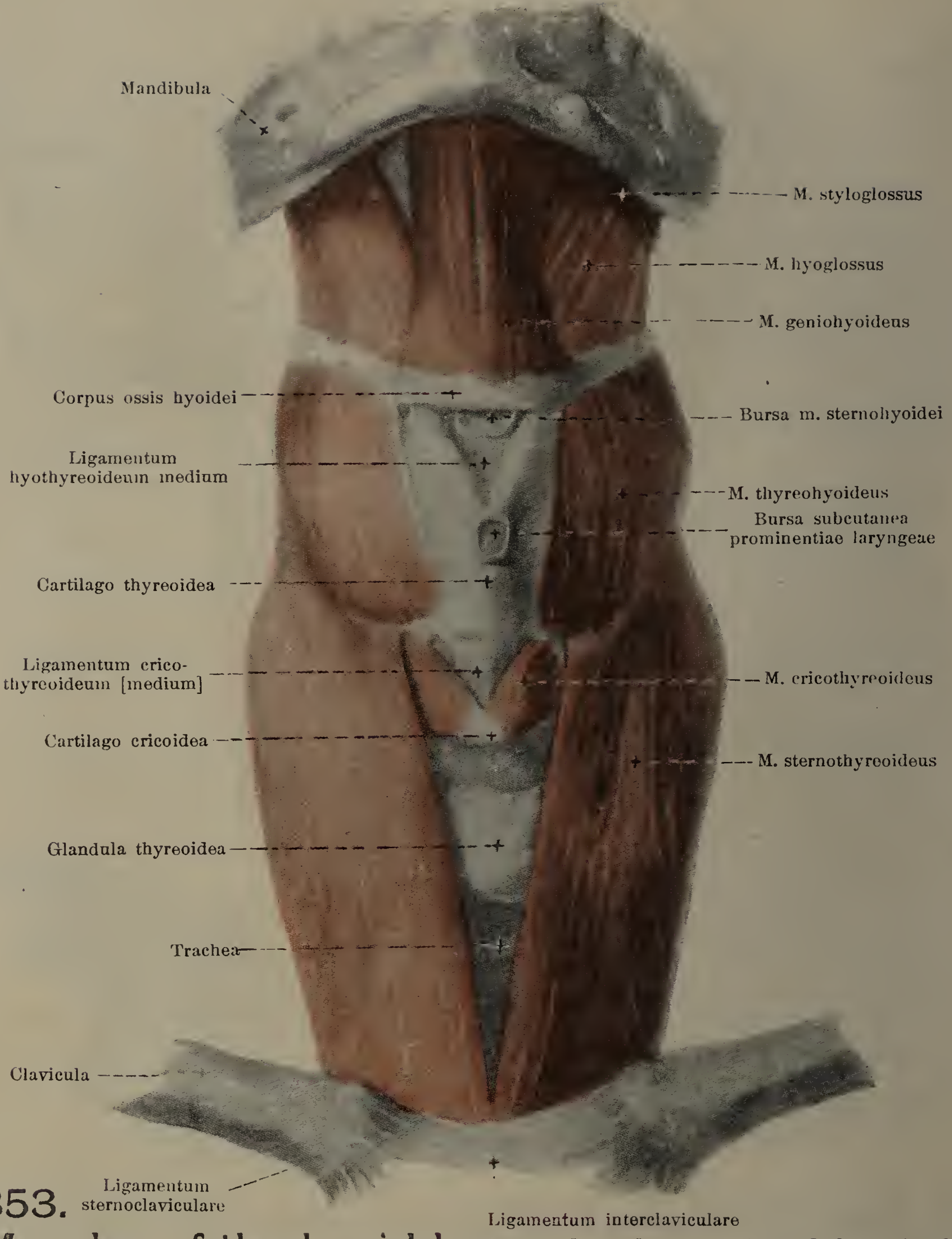
351. Muscles of the neck (3rd layer), viewed from in front. (Like Fig. 349; in addition however the mm. sternocleidomastoidei, trapezii and digastrici have been removed; the right clavicle has been sawed through close to the sternum and removed.)

M. omohyoideus (see also Figs. 349, 350 and 352). Form : flat narrow, long; divided in the centre by an intermediate tendon into two bellies, *venter inferior* and *venter superior.* Position: on the lateral and anterior surface of the neck, covered behind and below by the clavicula and the m. trapezius, in the middle by the m. sternocleidomastoideus. The intermediate tendon is ensheathed in the fascia colli and united with the anterior wall of the v. jugularis interna; the venter inferior is attached by stiff connective tissue to the clavicle. Origin : margo superior scapulae and lig. transversum scapulae superius, extending to the proc. coracoideus. Insertion : runs in front of the mm. scaleni forward and upward to the intermediate tendon and thence, bends upward to the corpus oss. hyoidei, where it lies laterally from the m. sternohyoideus and in front of the m. thyreohyoideus. Action: it draws the hyoid bone downward, makes the fascia colli tense, and somewhat extends the v. jugularis interna. Innervation: r. descendens n. hypoglossi (fibres from C_1, C_2, C_3).



352. Muscles of the neck (3rd layer), viewed from the right side.
The platysma, m. sternocleidomastoideus and the anterior part of the m. trapezius have been removed.)

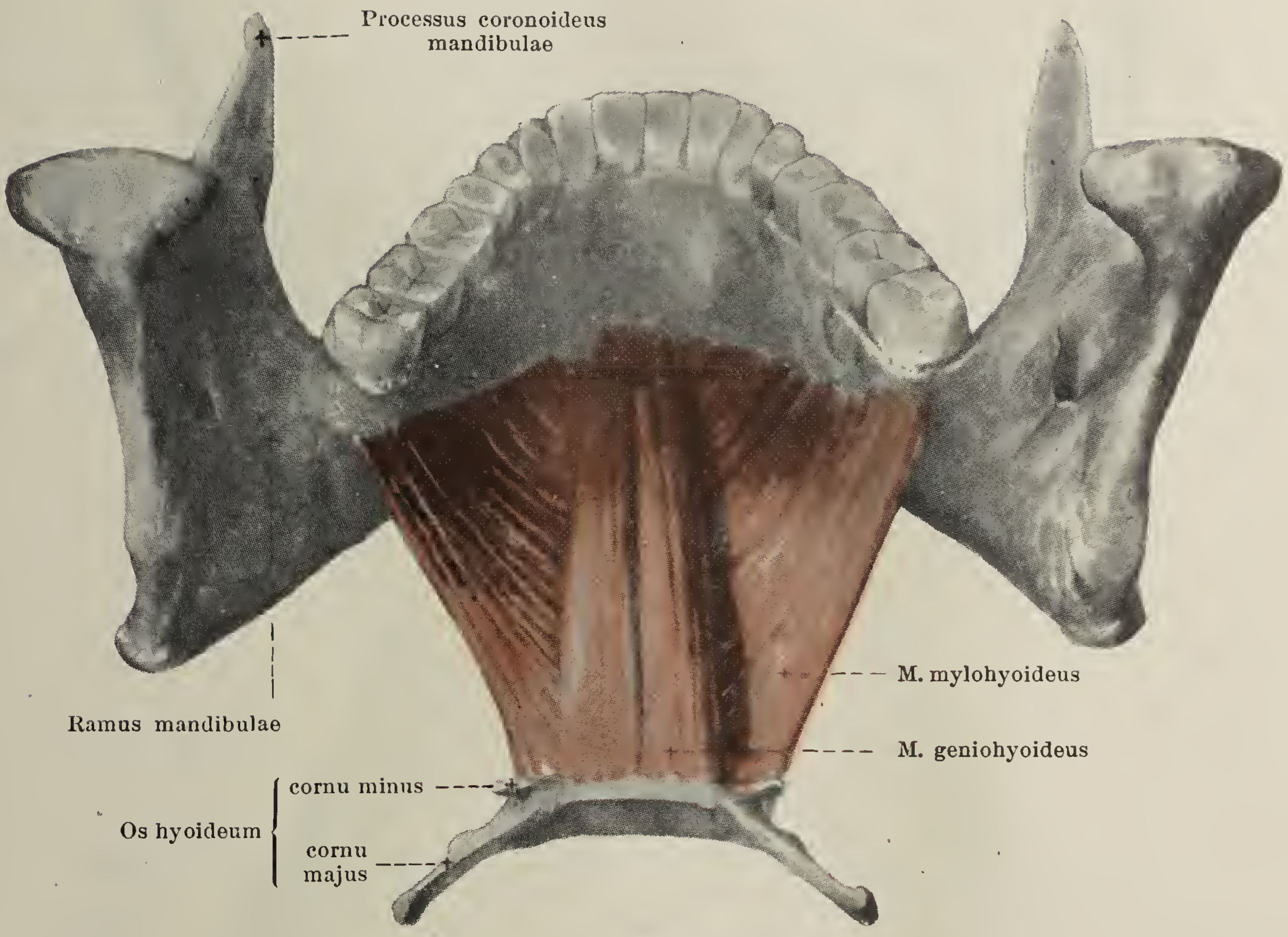
M. sternohyoideus (see also Figs. 349—351). Form: flat, oblong-quadrangular, thin, mostly having an inscriptio tendinea near its origin. Position: on the anterior surface of the neck in front of the larynx, the trachea and the glandula thyreoidea, next to the mm. sternothyreoideus and thyreohyoideus, covered above by the platysma, below by the m. sternocleidomastoideus; the muscles of the two sides approach very close to each other a little above their origin and sometimes even touch in the median line. Origin: posterior surface of the manubrium sterni, of the articulatio sternoclavicularis and of the clavicle (see Fig. 364). Insertion: the fibres run parallel to one another upward, at first also somewhat medianward, and go to the corpus oss. hyoidei *(bursa m. sternohyoidei*, see p. 275). Action: it draws the hyoid bone downward. Innervation: r. descendens n. hypoglossi (fibres from C_1, C_2, C_3).



353. **Muscles of the hyoid bone** (deep layer), viewed from in front.
(The mm. sternohyoidei, omohyoidei, digastrici and mylohyoidei have been removed.)

M. sternothyreoideus (see also Figs. 349, 351 and 352). Form: flat, oblong-quadrangular, very thin, often having an inscriptio tendinea. Position: on the anterior surface of the neck, close to the glandula thyreoidea, covered by the mm. omohyoideus and sternohyoideus. Origin: posterior surface of the manubrium sterni and of the first costal cartilage (see Fig. 364). Insertion: upward and at the same time slightly lateralward to the lamina cartilaginis thyreoideae (linea obliqua); single fibres go over immediately into the mm. thyreohyoideus and thyreopharyngeus. Action: it draws the cartilage thyreoidea downward. Innervation: r. descendens n. hypoglossi (fibres from C_1, C_2, C_3 [C_4]).

M. thyreohyoideus (see also Figs. 349—352). Form: flat, quadrangular, very thin. Position: on the anterior surface of the neck, close to the cartilago thyreoidea, covered by the mm. omohyoideus and sternohyoideus. Origin: lamina cartilaginis thyreoideae (linea obliqua) (see also above). Insertion: corpus and cornu majus oss. hyoidei ***(bursa m. thyreohyoidei***, see p. 275). Action: draws the hoid bone closer to the cartilago thyreoidea and vice versa. Innervation: r. thyreohyoideus n. hypoglossi (fibres from C_1 [C_2]).



354. Muscles of the floor of the mouth,

viewed from behind and above.

(The muscles of the tongue have been completely removed.)

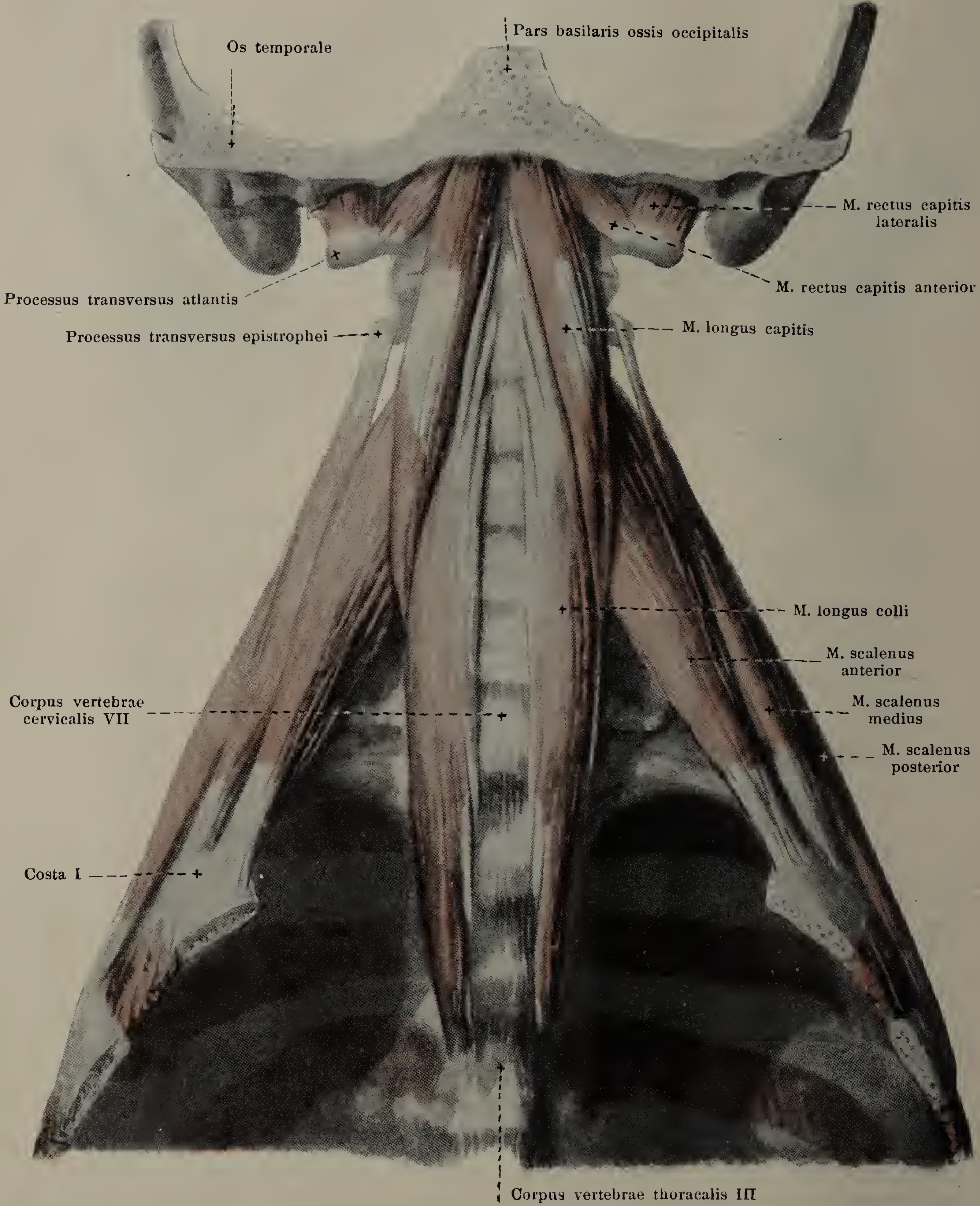
M. mylohyoideus (see also Figs. 349, 351 and 568). Form: flat, triangular, broad; the right and the left muscle together are hollowed above out like an trough. Position: the right and the left commonly stretch between the lower jaw and the hyoid bone and thus form the floor of the mouth; immediately adjacent to its lower surface lies on each side the anterior belly of the m. digastricus and the glandula submaxillaris. Origin: linea mylohyoidea mandibulae. Insertion: the fibres run, parallel to one another, backward, downward and medianward and are attached for the most part to a connective tissue raphe situated in the median plane; the posterior fibres go to the anterior surface of the corpus oss. hyoidei. Action: when the lower jaw is fixed, it draws the hyoid bone forward and upward and raises the tongue, when the hyoid bone is fixed, it depresses the lower jaw. Innervation: n. mylohyoideus (V. 3).

M. geniohyoideus (see also Figs. 353, 568 and 582). Form: flat-cylindrical, oblong. Position: on the upper (buccal) side of the m. mylohyoideus, completely hidden by it from below; the mm. geniohyoidei of the two sides are immediately adjacent to one another in the median plane. Origin: by a short tendon from the spina mentalis mandibulae. Insertion: the fibres, diverging a little, extend to the anterior surface of the corpus oss. hyoidei. Action: when the lower jaw is fixed, it draws the hyoid bone forward and upward; when the hyoid bone is fixed, it depresses the lower jaw. Innervation: C_1, C_2 and very probably also n. hypoglossus.

Bursa [mucosa] subcutanea prominentiae laryngeae (see Fig. 353), often absent, usually found only in men and only in older individuals; it is unpaired and lies in the subcutaneous tissue in front of the upper part of the thyroid cartilage.

Bursa m. sternohyoidei (see Fig. 353), almost constant, is better developed in the male than in the female and lies, if unpaired, in the median plane or, if paired, close to the median plane upon the lig. hyothyreoideum medium, between it on the one hand and the m. sternohyoideus and the fascia colli on the other; it extends upward behind the hyoid bone.

Bursa m. thyreohyoidei (not shown in the drawing), still more constant than the preceding, lies below the cornu majus oss. hyoidei, upon the membrana hyothyreoidea, between it and the upper end of the m. thyreohyoideus.

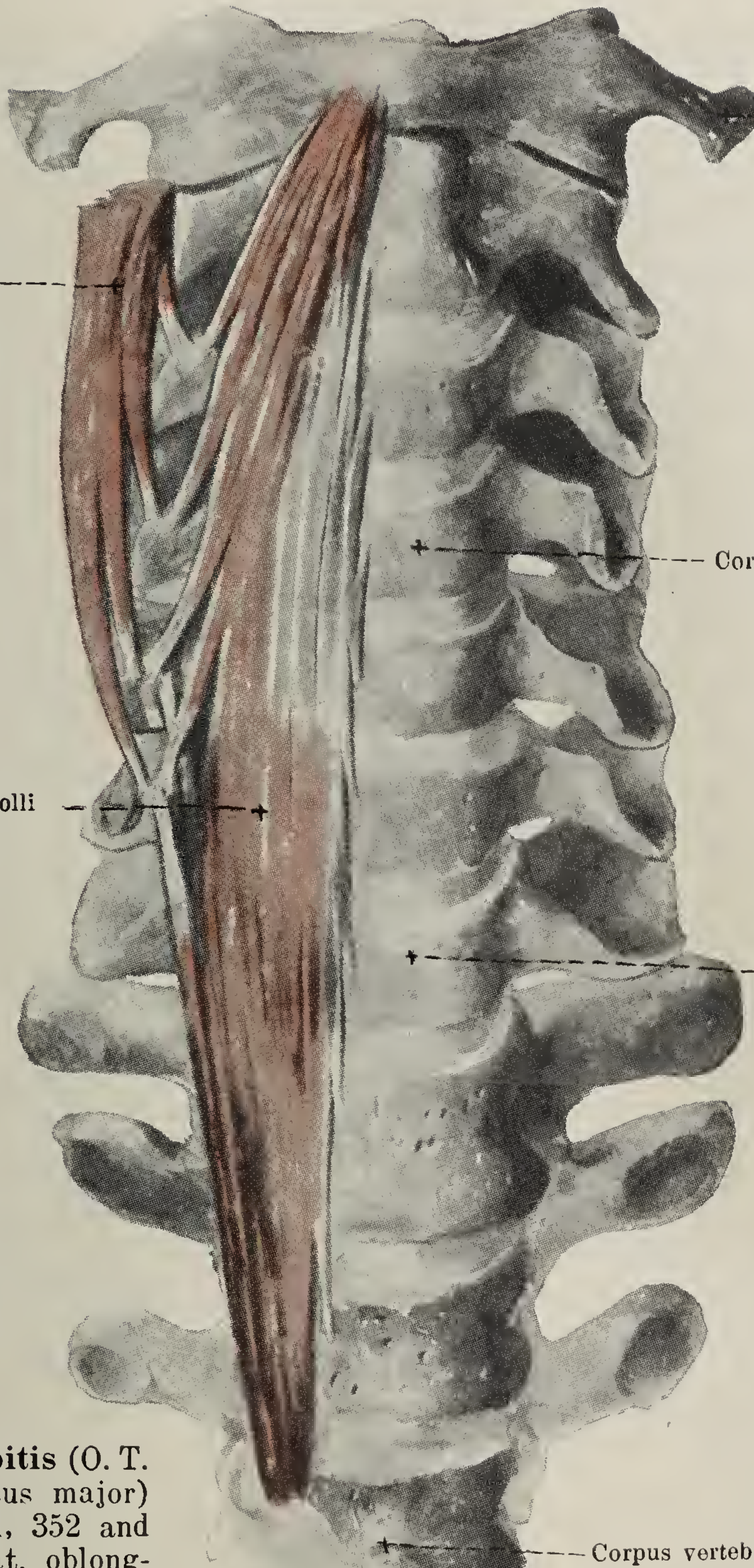

Os temporale
Pars basilaris ossis occipitalis
M. rectus capitis lateralis
M. rectus capitis anterior
Processus transversus atlantis
Processus transversus epistrophei
M. longus capitis
M. longus colli
M. scalenus anterior
Corpus vertebrae cervicalis VII
M. scalenus medius
M. scalenus posterior
Costa I
Corpus vertebrae thoracalis III

355. Deep muscles of the neck, viewed from in front.

(The sternum and the anterior ends of the ribs with their muscles have been removed.)

M. rectus capitis lateralis. Form: flat, short. Position: lateral from the articulatio atlantooccipitalis. Origin: proc. transversus atlantis. Insertion: inferior surface of the proc. jugularis oss. occipit.. Action: bends the head to the side. Innervation: direct branch of the plexus cervicalis (C_1).

M. rectus capitis anterior (O. T. rectus capitis anticus minor). Form: flat, short. Position: in front of the articulatio atlantooccipitalis. Origin: massa lateralis and root of the proc. transversus atlantis. Insertion: pars basilaris oss. occipit.. Action: bends the head forward. Innervation: direct branch of the plexus cervicalis (C_1, C_2).


Processus transversus atlantis
M. longus capitis (cut through and turned lateralward)
Corpus vertebrae cervicalis IV
M. longus colli
Corpus vertebrae cervicalis VII
Corpus vertebrae thoracalis III

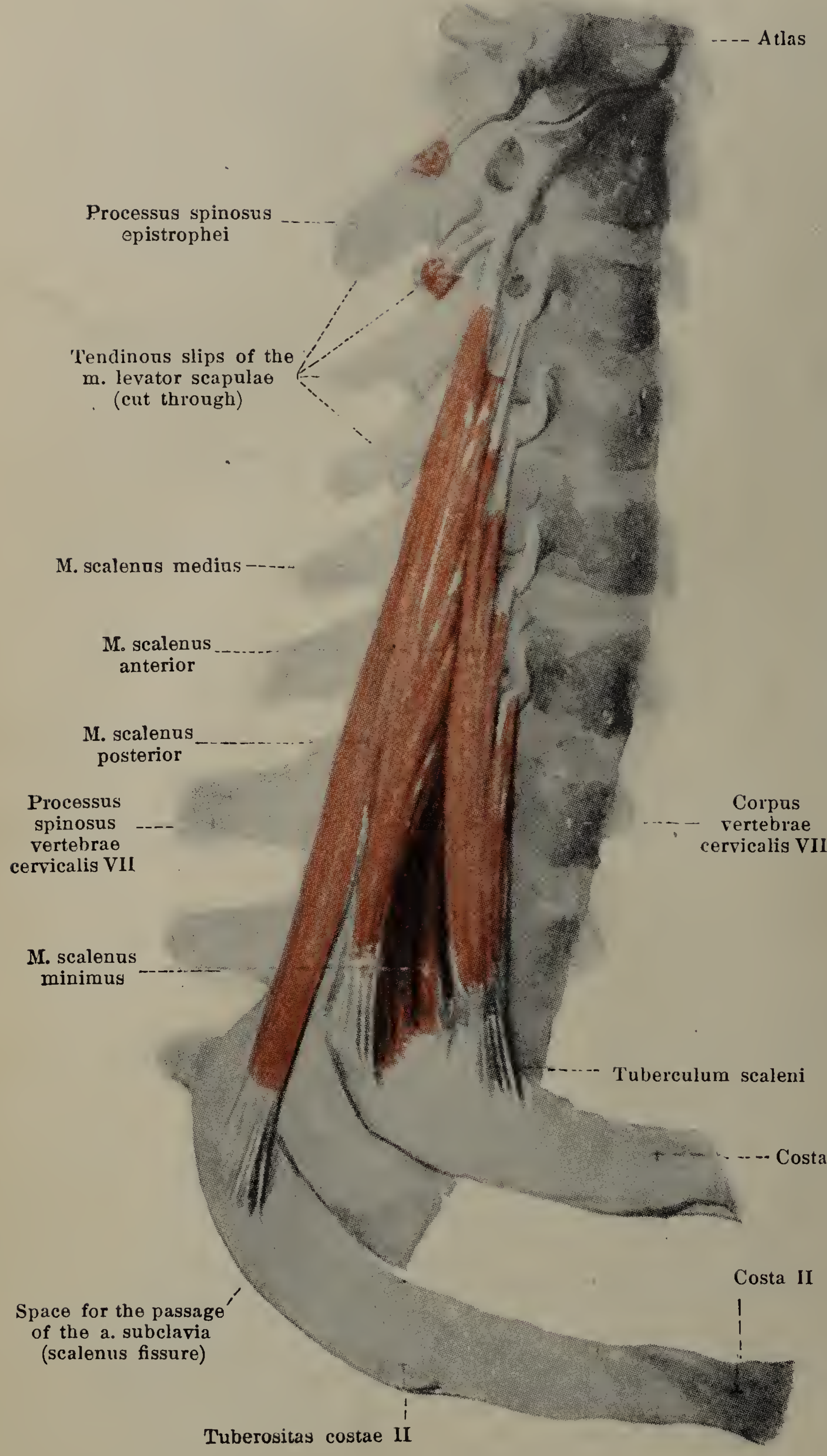
356. Anterior muscles of the cervical spine on the right side.

M. longus capitis (O. T. rectus capitis anticus major) (see also Figs. 351, 352 and 355). Form: flat, oblong-triangular; has in the middle part on the anterior surface an oblong field of tendons. Position: just in front of the upper end of the cervical spine and in front of the membrana atlantooccipitalis anterior. Origin: tubercula anteriora of the transverse processes of the 3rd—6th cervical vertebra. Insertion: upward and medianward to the pars basilaris oss. occipitalis. Action: bends the head and the upper cervical vertebrae forward and the cervical spine lateralward. Innervation: direct branch of the plexus cervicalis (C_1, C_2, C_3).

M. longus colli (see also Fig. 355). Form: flat, oblong-triangular, broadest in the middle. Position: close to the anterior surface of the cervical spine and of the upper thoracic vertebrae, in the groove between the bodies and transverse processes of the vertebrae; it is partially covered above by the m. longus capitis. Two portions. Inferior, medial portion: from the bodies of the 3rd thoracic to the 5th cervical vertebra, goes to the bodies of the 4th—2nd cervical vertebra and to the anterior tubercles of the transverse processes of the 6th and 5th cervical vertebra; superior, lateral portion: from the anterior tubercles of the transverse processes of the 6th—3rd cervical vertebra, goes to the tuberculum anterius atlantis. Action: bends the cervical spine forward and lateralward. Innervation: direct branches of the cervical and brachial plexuses (C_2, C_3, C_4, C_5, C_6).

357. Mm. scaleni of the right side,

viewed from the right.

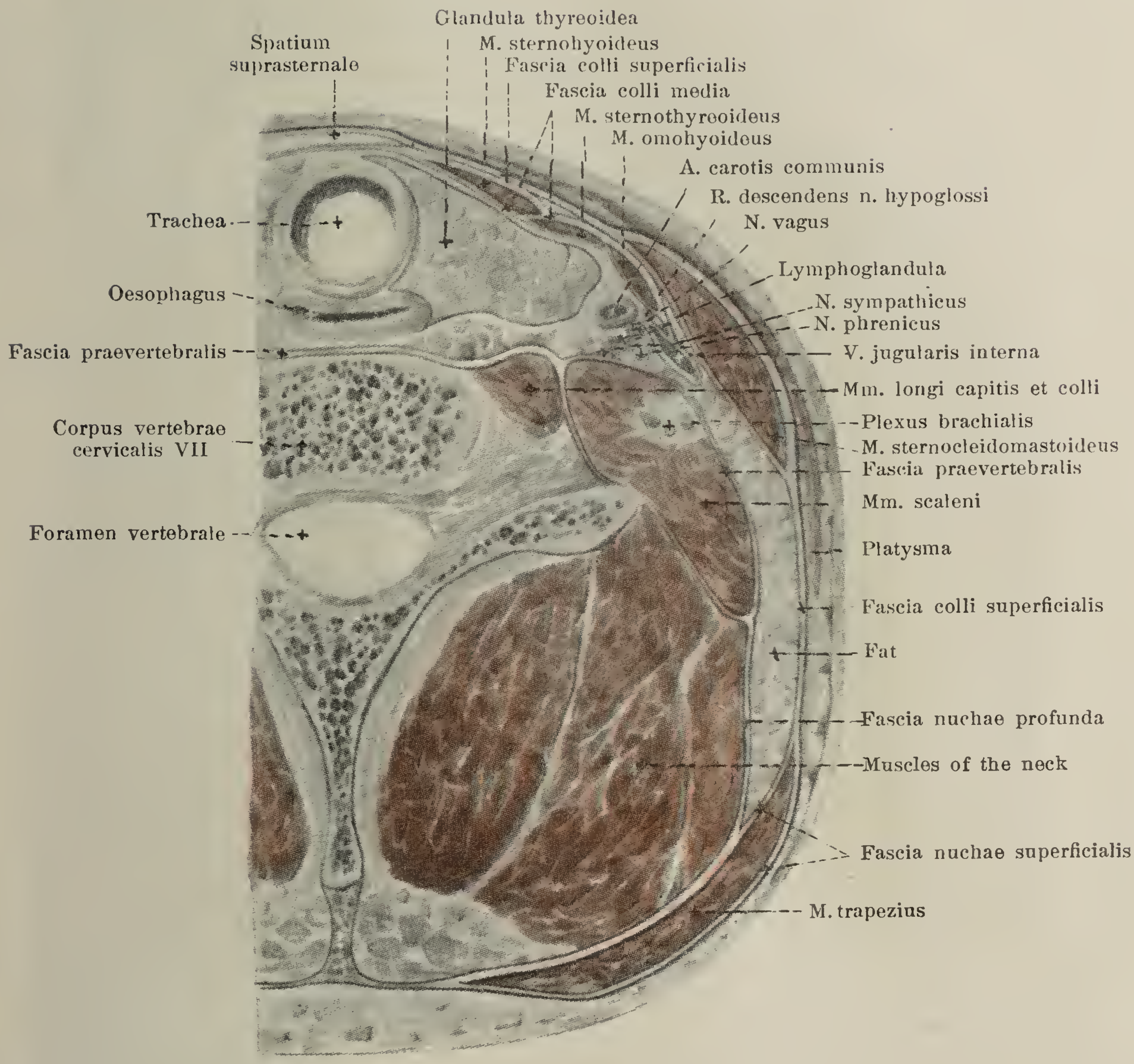

Atlas
Processus spinosus epistrophei
Tendinous slips of the m. levator scapulae (cut through)
M. scalenus medius
M. scalenus anterior
M. scalenus posterior
Processus spinosus vertebrae cervicalis VII
Corpus vertebrae cervicalis VII
M. scalenus minimus
Tuberculum scaleni
Costa 1
Costa II
Space for the passage of the a. subclavia (scalenus fissure)
Tuberositas costae II

M. scalenus anterior (O. T. scalenus anticus) (see also Figs. 350 to 352 and 355). Form: flat, oblong-quadrangular. Position: close to the inferior part of the cervical spine. Origin: by four tendinous slips from the anterior tubercles of the transverse processes of the 3rd to the 6th cervical vertebra. Insertion: downward and forward by means of a short tendon to the tuberculum scaleni [Lisfranci] of the 1st rib. Action: when the cervical spine is fixed it elevates the 1st rib; when the 1st rib is fixed it bends the cervical spine forward and lateralward; and when acting with its fellow of the opposite side the two bend the cervical spine directly forward. Innervation: direct branches of the cervical and brachial plexuses ([C_4],C_5,C_6,C_7).

M. scalenus medius (see also Figs. 350—352 and 355). Form: flat, oblong-triangular. Position: close to the inferior part of the cervical spine, behind the m. scalenus anterior, separated from it at the 1st rib by a triangular space (*scalenus fissure).* Origin: by 6 (7) slips from and beside the posterior tubercles of the transverse processes of the 7th—2nd (1st) cervical vertebra. Insertion: downward and lateralward to the lateral surface of the 1st rib (behind the sulcus subclaviae). Action: when the cervical spine is fixed it elevates the 1st rib; when the 1st rib is fixed it bends the cervical spine lateralward. Innervation: direct branches of the cervical and brachial plexuses ([C_4], C_5, C_6, C_7, C_8).

M. scalenus posterior (O. T. scalenus posticus) (see also Figs. 350—352 and 355). Form: flat, oblong-quadrangular. Position: close to the inferior part of the cervical spine, bounded in front by the m. scalenus medius, behind by the m. iliocostalis cervicis, lateralward by the m. levator scapulae; usually fused with the m. scalenus medius. Origin: by 2 slips from the posterior points of the transverse processes of the 5th and 6th cervical vertebrae. Insertion: downward and lateralward to the lateral surface of the 2nd rib. Action: is related to the 2nd rib as is that of the preceding muscle to the 1st rib. Innervation: direct branches of the brachial plexus (C_7 or C_8).

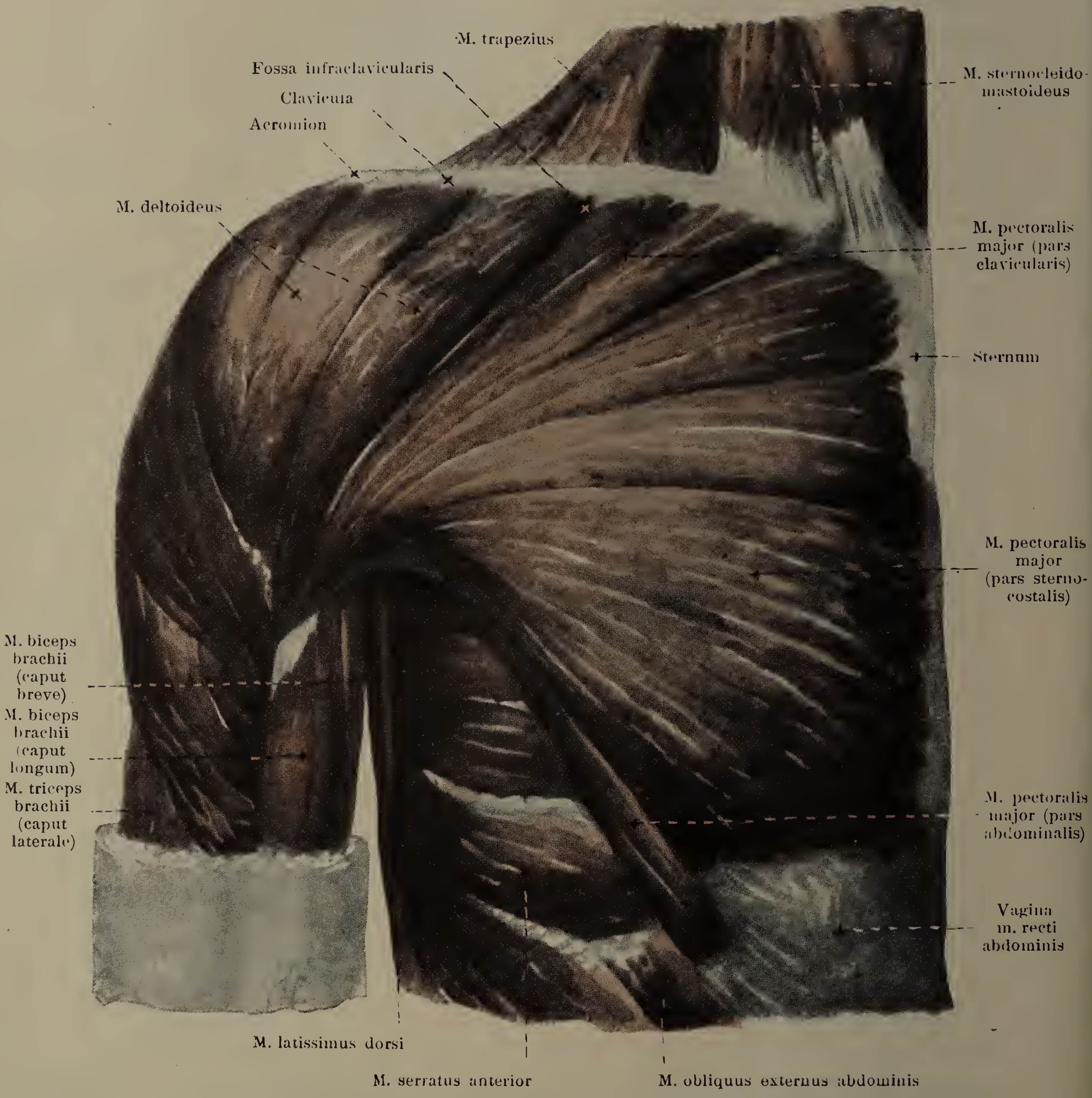
M. scalenus minimus (inconstant). Form: flatly-rounded, narrow. Position: in the slit between the mm. scalenus anterior and medius; it separates the brachial plexus from the a. subclavia. Origin: by 1—2 slips from the transverse processes of the 7th or of the 6th and 7th cervical vertebra. Insertion: downward and forward to the lateral surface of the 1st rib and to the pleural cupola. Action: makes the pleural cupola tense. Innervation: direct branches of the brachial plexus (C_8).



358. Transverse section through the neck, at the level of the uppermost cartilages of the trachea, viewed from above (after Fr. Merkel).

The **fascia praevertebralis** is a thin but strong membrane which covers the anterior surface of the cervical spine and the deep muscles of the neck; part of it descends with these into the thorax, part extends upon the outer surface of the mm. scaleni and of the thorax: it covers directly all the muscles of the neck represented in Fig. 355.

The **fascia colli** extends as a strong membrane from the hyoid bone to the sternum and clavicle in front of the larynx, laryngeal muscles and trachea. It is attached to the sternum by two leaves, which enclose the *spatium suprasternale* and its fatty contents. Laterally it extends above in front of the m. omohyoideus and past it as far as the anterior surface of the bundle of blood vessels, where it becomes lost; it forms a sheath for the intermediate tendon and the venter inferior of the m. omohyoideus. Behind, it becomes thinner and passes below the m. sternocleidomastoideus, upon the fat which helps to fill up the lateral cervical triangle, and below the m. trapezius to the lig. nuchae; the external surface of the mm. sternocleidomastoideus and trapezius is covered only by delicate muscle-fascia.

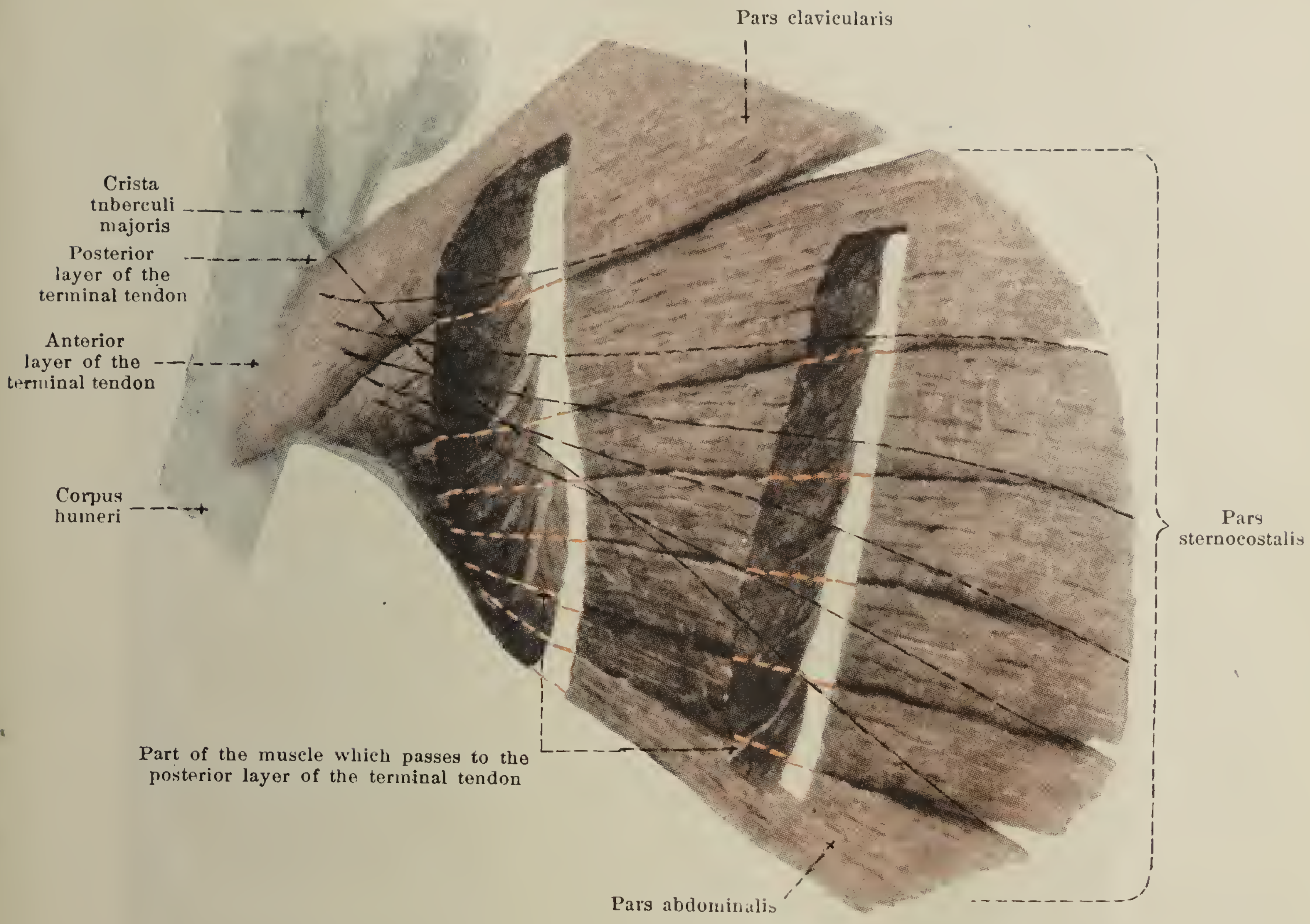

M. trapezius
Fossa infraclavicularis
Clavicula
Acromion
M. sternocleidomastoideus
M. deltoideus
M. pectoralis major (pars clavicularis)
Sternum
M. pectoralis major (pars sternocostalis)
M. biceps brachii (caput breve)
M. biceps brachii (caput longum)
M. triceps brachii (caput laterale)
M. pectoralis major (pars abdominalis)
Vagina m. recti abdominis
M. latissimus dorsi
M. serratus anterior
M. obliquus externus abdominis

359. Muscles of the right side of the chest,

viewed from in front.

(The platysma has been removed.)

M. pectoralis major (see also Figs. 360, 367, 368 and 394). Form: flat, quadrangular when the arm is hanging down, broad, thick. Position: on each side it passes out from the median plane to the anterior surface of the thorax and of the axilla, above it is partly covered by the platysma; separated from the muscle of the other side by a groove of varying depth. Origin: medial half up to two third of the clavicle *(pars clavicularis)*, anterior surface of the sternum and of the second to the sixth costal cartilage *(pars sternocostalis)*, and the anterior leaf of the vagina m. recti abdominis *(pars abdominalis)*. The pars clavicularis is as a rule distinctly separated at the sternoclavicular joint from the pars sternocostalis by an open space, and remains separated from it in its entire length. Insertion: see p. 281.

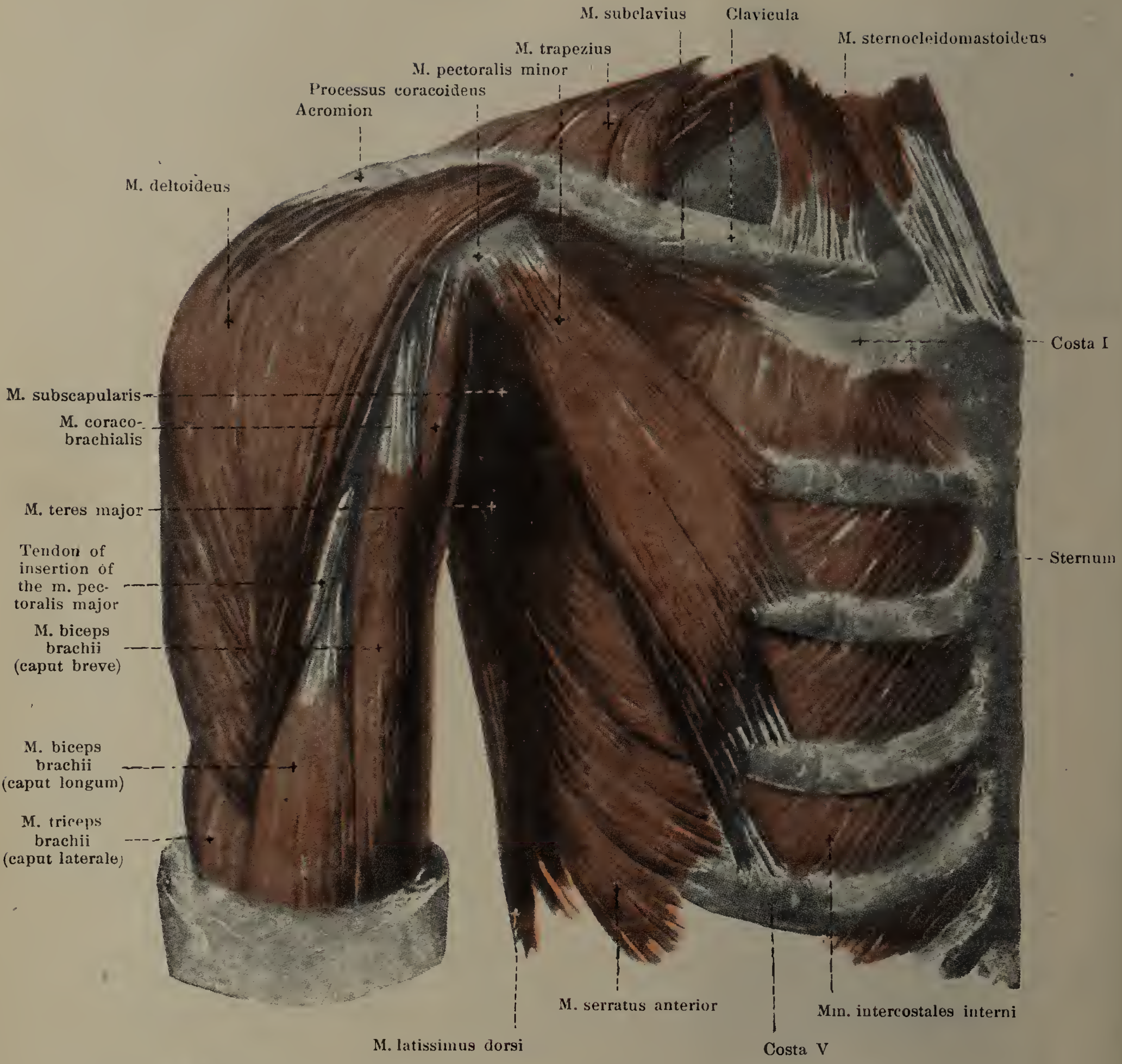

Pars clavicularis
Crista tuberculi majoris
Posterior layer of the terminal tendon
Anterior layer of the terminal tendon
Corpus humeri
Pars sternocostalis
Part of the muscle which passes to the posterior layer of the terminal tendon
Pars abdominalis

360. Right m. pectoralis major,

viewed from in front, semi-schematically.

(Two strips have been cut out of the muscle. The dotted black lines indicate the course of the upper, posterior margins of the muscle bundles, the dotted red lines that of the lower, anterior margins.)

M. pectoralis major (continued). Insertion: The fibres converge lateralward to the crista tuberculi majoris of the humerus and there become attached by tendons. The pars clavicularis runs in parallel fibres to the anterior part of the terminal tendon; a lateral triangular field of the terminal tendon is here covered by the anterior part of the m. deltoideus. The pars sternocostalis usually converges toward a thick, tendinous plate in the posterior section of the tendon of insertion, and can be divided into several large compartments which run fan-shaped after one another toward the humerus. The lowest part of the pars sternocostalis and the pars abdominalis run slightly twisted without deviating to any marked degree from their path to a tendinous leaf on the dorsal surface of the tendon of insertion, this leaf being connected by loose tissue with the rest of the tendinous mass; the same leaf may rise above the proximal margin of the latter. The tendon of insertion, accordingly, consists of two layers, one anterior, thick (formed by the pars clavicularis and the main mass of the pars sternocostalis), and one posterior, thin (pertaining to the lower part of the pars sternocostalis and to the pars abdominalis); these layers are continuous below but can be separated from above (see Fig. 361). The tendon of insertion is connected below with that of the m. deltoideus. Its posterior layer sometimes divides before it is attached and encloses the tendon of the caput longum m. bicipitis; it also lines the groove between the cristae tuberculi majoris and tuberculi minoris, and is there united with the tendinous fibres of the m. latissimus dorsi. Between the posterior surface of the terminal tendon and the anterior surface of the caput longum m. bicipitis brachii there often lies an oblong bursal sack, **bursa m. pectoralis majoris** (see Fig. 397). Action: it moves the scapula forward, draws the upper arm medianward and forward, and rotates it inward; it draws the vertically elevated upper arm downward; the upper part presses the arm somewhat upward against the scapula, and can also raise the cingulum extremitatis superioris a trifle; the lower part can raise the ribs when the shoulder girdle is fixed. Innervation: nn. thoracales anteriores ([C_5], $\mathbf{C_6}$, $\mathbf{C_7}$, $\mathbf{C_8}$, Th_1).

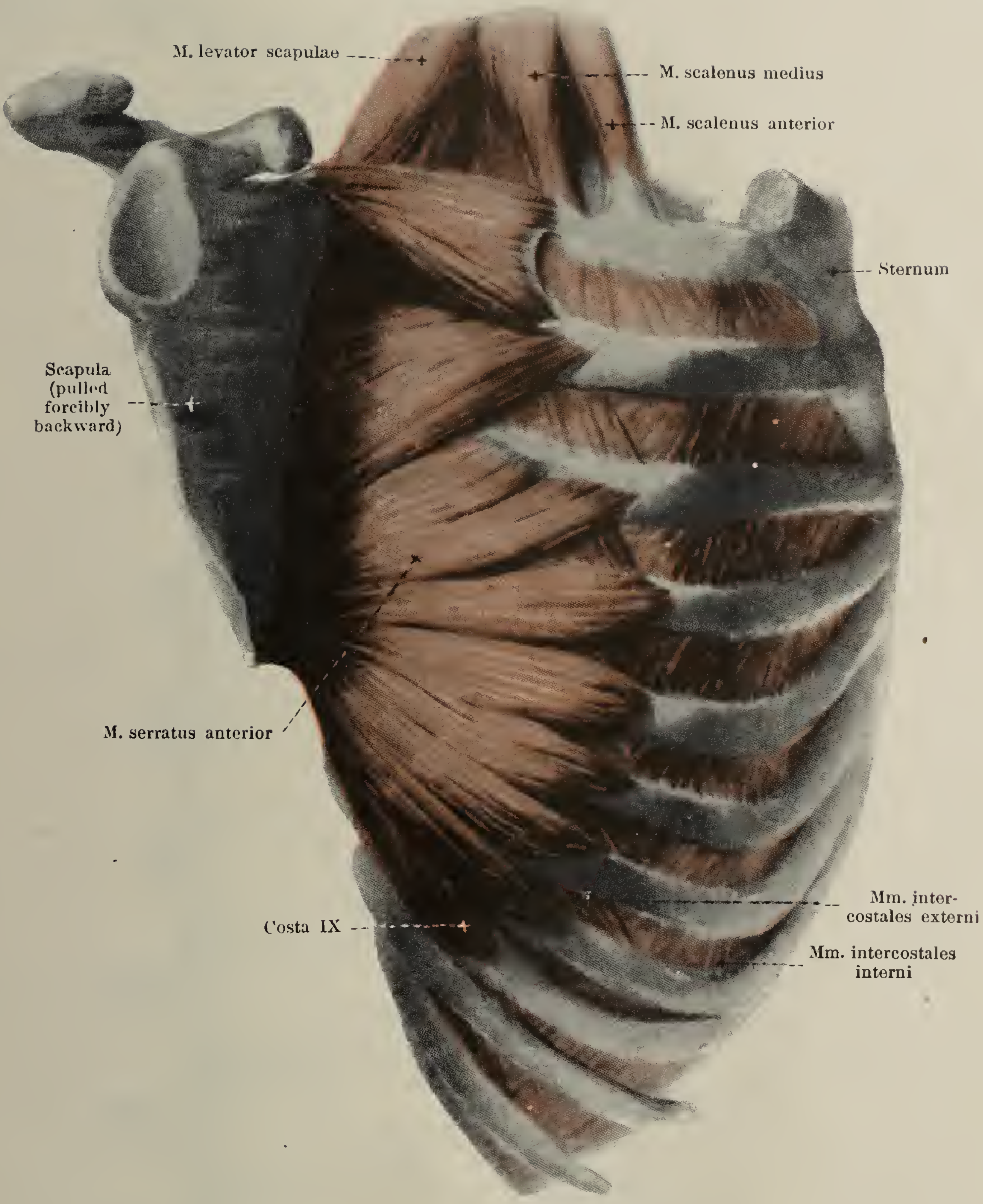


361. Muscles of the right side of the chest (2nd layer), viewed from in front.

(The platysma and the m. pectoralis major have been removed.)

M. pectoralis minor. Form: flat, oblong-triangular. Position: on the anterior surface of the thorax and of the axilla, covered by the m. pectoralis major; it may project somewhat beyond the lateral margin of the m. pectoralis major. Origin: by (four or) three digitations from the anterior surface of the (2nd or) 3rd—5th rib. Insertion: the fibres converge upward and lateralward to the proc. coracoideus scapulae; there is a short tendon which may be united with the m. coracobrachialis. Action: it moves the scapula (and the clavicle) downward and turns its angulus inferior backward and medianward; when the shoulder blade is fixed, it elevates the ribs to which it is attached. Innervation: nn. thoracales anteriores (C_7, C_8).

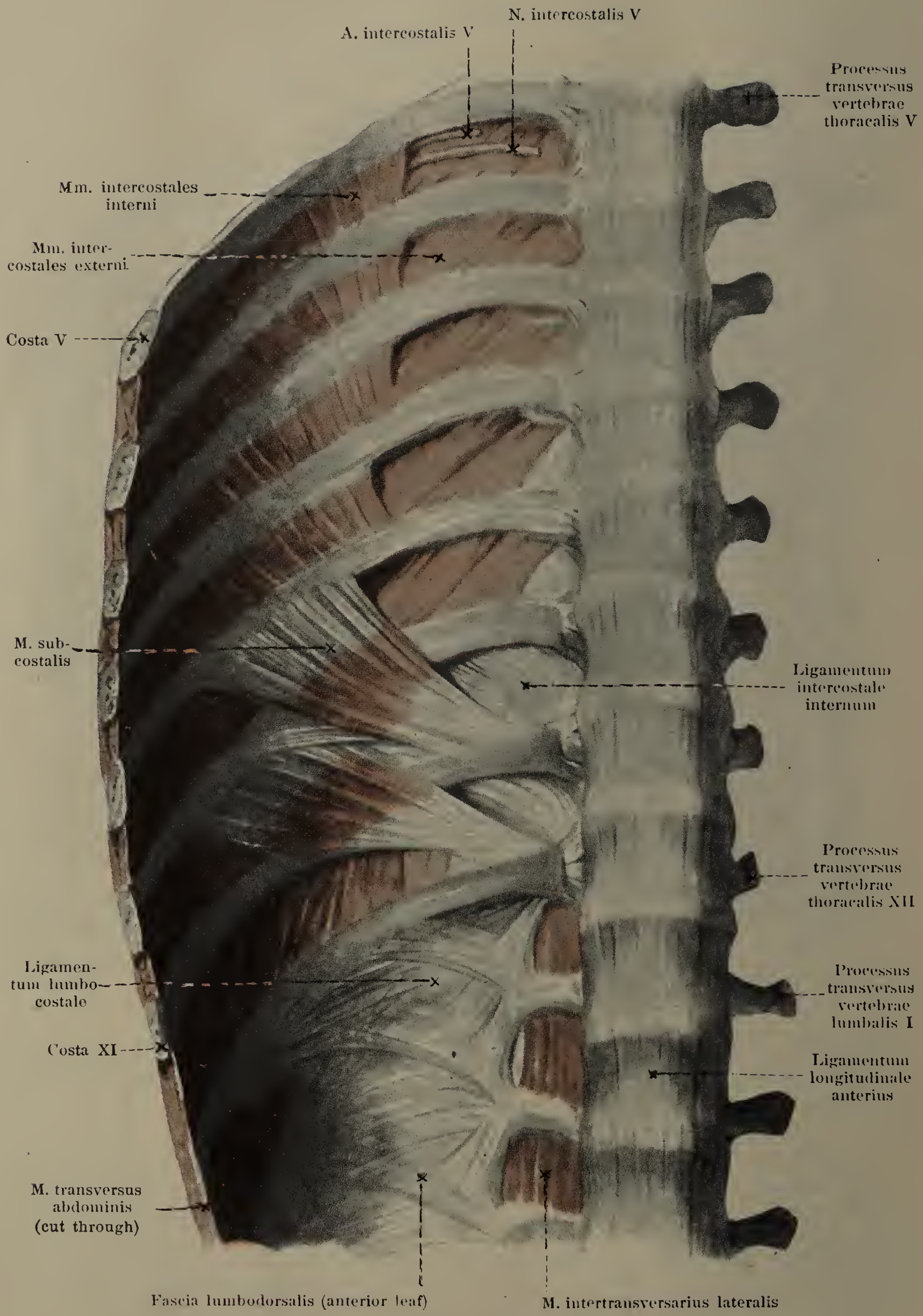
M. subclavius. Form: flat-cylindrical, narrow, short, pinnated. Position: hidden between the clavicle and the 1st rib, covered by the platysma, the clavicle and the m. pectoralis major. Origin: with a strong tendon, from the anterior surface of the 1st costal cartilage and 1st rib, just lateralward from the lig. costoclaviculare. Insertion: obliquely lateralward and upward to the inferior surface of the clavicle as far as the lig. coracoclaviculare and between its two parts. Action: it draws the clavicle (and the scapula) downward and forward. Innervation: n. subclavius (C_5 [C_6]).



362. Right m. serratus anterior,

viewed from the side and somewhat from in front.

(The mm. pectorales as well as the muscles of the anterior and posterior scapular fossae have been removed; the clavicle has also been removed and the scapula drawn forcibly backward.)


N. intercostalis V
A. intercostalis V
Processus transversus vertebrae thoracalis V
Mm. intercostales interni
Mm. intercostales externi
Costa V
M. subcostalis
Ligamentum intercostale internum
Processus transversus vertebrae thoracalis XII
Processus transversus vertebrae lumbalis I
Ligamentum lumbocostale
Costa XI
Ligamentum longitudinale anterius
M. transversus abdominis (cut through)
Fascia lumbodorsalis (anterior leaf)
M. intertransversarius lateralis

363. Right posterior wall of the thorax with muscles, viewed from in front.

(Diaphragma, m. psoas and m. quadratus lumborum have been removed. The ligamenta intercostalia interna are cut off in the 5th—9th intercostal space.)

M. serratus anterior (O. T. serratus magnus) (see Figs. 359, 361, 362, 367, 368 and 394). Form: flat, quadrangular. Position: on the lateral and posterior wall of the thorax, close to the ribs and mm. intercostales, covered in front and above by the mm. pectorales, behind by the m. subscapularis, by the scapula and its posterior muscles as well as by the m. latissimus dorsi and m. trapezius; lateralward and below, with its 4—5 inferior digitations, which penetrate between the digitations of the m. obliquus externus abdominis, just beneath the skin. Origin: by 9—10 fleshy digitations from the 8—9 uppermost ribs (by 2 digitations from the 2nd rib [tuberositas costae II]); also from a tendinous arch between 1st and 2nd rib. Insertion: uppermost 2 digitations (from 1st and 2nd rib) converging to the angulus medialis scapulae; 3rd digitation (from 2nd rib) (occasiomally also the 4th digitation, from the 3rd rib) runs diverging to the margo vertebralis (the thinnest part); 4th—10th digitations (from 3rd—9th rib) extend converging to the angulus inferior; the latter portion is the strongest. The fibres run as a whole curved so as to be convex, follow exactly the curvature of the wall of the thorax and increase in length below; the fibres from the 5th—8th rib are the longest. Action: it presses the scapula to the thorax, draws it forward and lateralward, acting with especial power upon the angulus inferior; at the same time it rotates the scapula so that the angulus medialis is depressed and the acromion slightly elevated. Innervation: n. thoracalis longus (C_5, C_6, C_7 [C_8]).

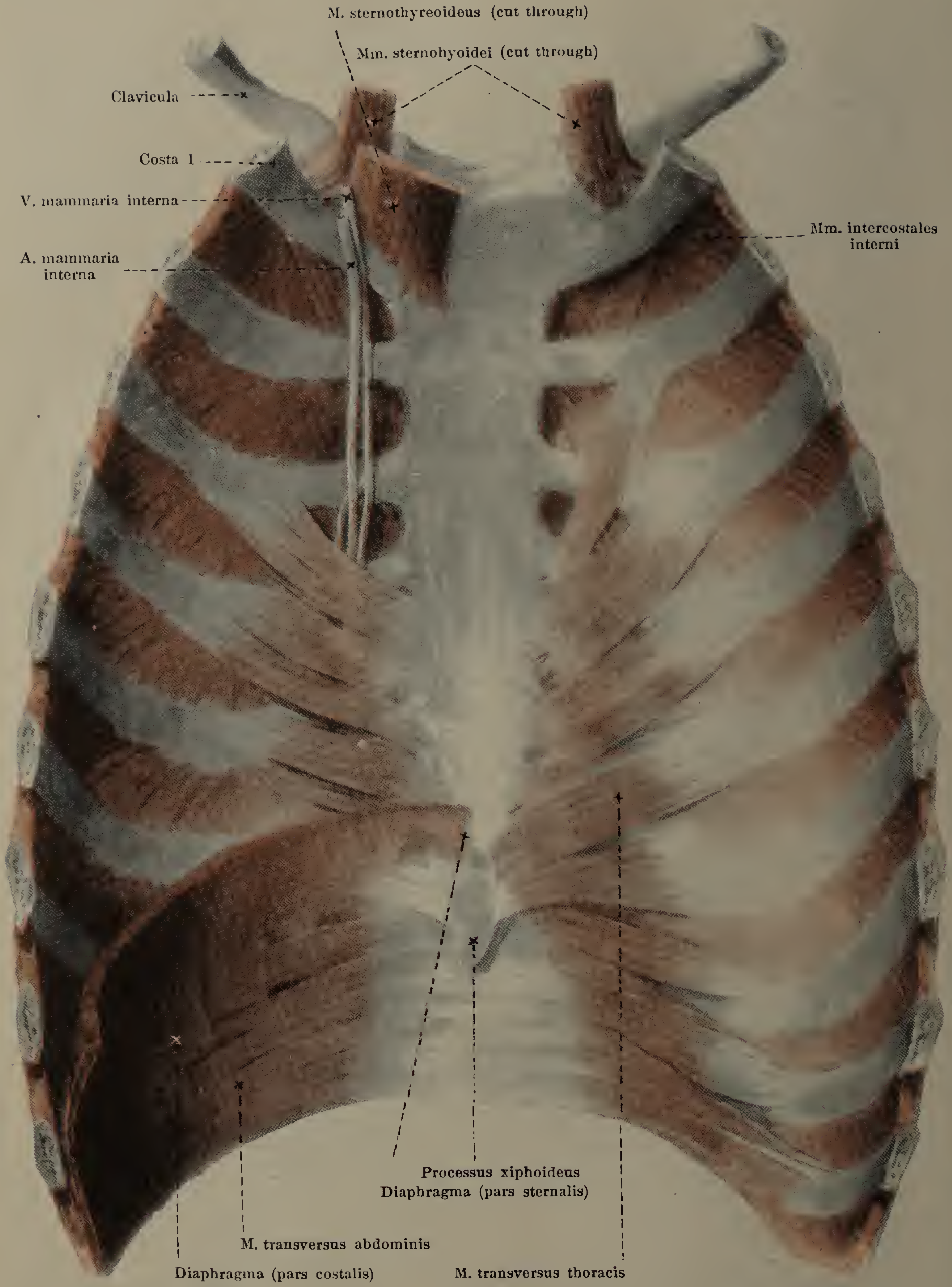
Mm. intercostales externi (see also Figs. 362, 370 and 387). Form: flat, short, thin; they contain a great deal of tendinous tissue. Position: in the intercostal spaces, from the tubercles of the ribs on, to about the lateral ends of the costal carilages; in the first intercostal space sometimes to the sternum; behind they are continous with the mm. levatores costarum. Origin: lower margin of each rib, external from the sulcus costae. Insertion: the fibres run parallel downward and sternalward to the upper margin of the next rib below. Medianward from the anterior end running in the same direction are glistening tendinous band of connective tissue *(ligamenta intercostalia externa*, not shown in the figure). Action: muscles contract on inspiration. Innervation: nn. intercostales I—XI.

Mm. intercostales interni (see also Fig. 361, 362, 364 and 372). Form: flat, short thin. Position: in the intercostal spaces from the region of the angles of the ribs to the sternum; they lie more internally than the mm. intercostales externi, and are accordingly covered by the latter externally as far as the lateral ends of the costal cartilages; between the costal cartilages they are covered only by the ligg. intercostalia externa; behind they leave the anterior surface of the mm. intercostales externi free medianward from the angles of the ribs. Origin: inferior margin of each rib; more exactly, inwards from the sulcus costae from the anguli costarum almost to the margin of the costal cartilage, and outwards from the sulcus costae in the middle of the rib to the sternum, so that the intercostal vessels and nerves run behind between the mm. intercostales externi and interni, then between the two layers of the mm. intercostales interni, and in front, on the inner side of the latter. Insertion: the fibres run parallel downward and vertebralward to the upper margin of the next rib below. Action: the portions extending between the ossa costalia contract on expiration; those bundles running between the costal cartilages, *mm. intercartilaginei*, act like the mm. intercostales externi. Innervation: nn. intercostales I—XI.

The *ligamenta intercostalia interna* are thin bands of connective tissue which are situated, partly in front on the inner side of the mm. intercostales interni in connection with the m. transversus thoracis (not shown in figure), partly behind on the anterior surface of the mm. intercostales externi in connection with the mm. intercostales interni and the mm. subcostales (see Fig. 363).

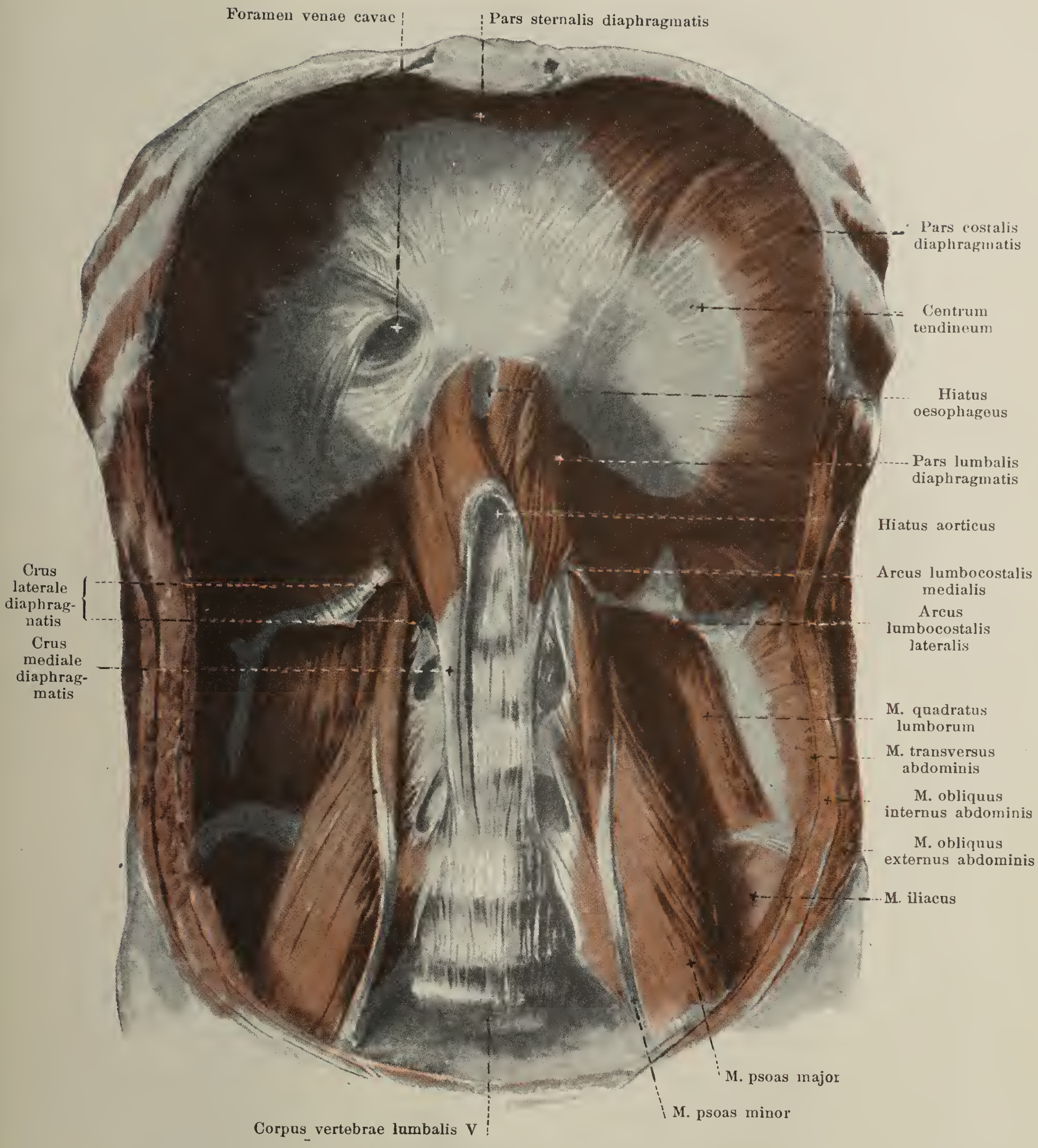
Mm. subcostales, very variable. Form: flat, triangular, very thin. Position: on the internal surface of the ribs, usually only of the lower ribs, in the region of the anguli costarum. Origin: from the inner surface of the ribs. Insertion: the fibres run like those of the mm. intercostales interni, but jump over one or two ribs. Action: contract on expiration. Innervation: corresponding nn. intercostales.

M. transversus thoracis (see Fig. 364). Form: flat, quadrangular, very thin. Position: directly upon the posterior surface of the anterior thoracic wall, below close to the diaphragma and bounding the m. transversus abdominis. Origin: posterior surface of the proc. xiphoideus and of the lower half of the corpus sterni. Insertion: lower bundle transverse, the upper obliquely upward and lateralward to the 6th to the 3rd (or 2nd) rib (costo-cartilaginous junction); the upper ones usually pass over two intercostal spaces. Action: it draws the ribs downward on expiration. Innervation: nn. intercostales III (or II)—IV.


M. sternothyreoideus (cut through)
Mm. sternohyoidei (cut through)
Clavicula
Costa I
V. mammaria interna
A. mammaria interna
Mm. intercostales interni
Processus xiphoideus
Diaphragma (pars sternalis)
M. transversus abdominis
Diaphragma (pars costalis)
M. transversus thoracis

364. Anterior wall of the thorax with muscles, viewed from behind.

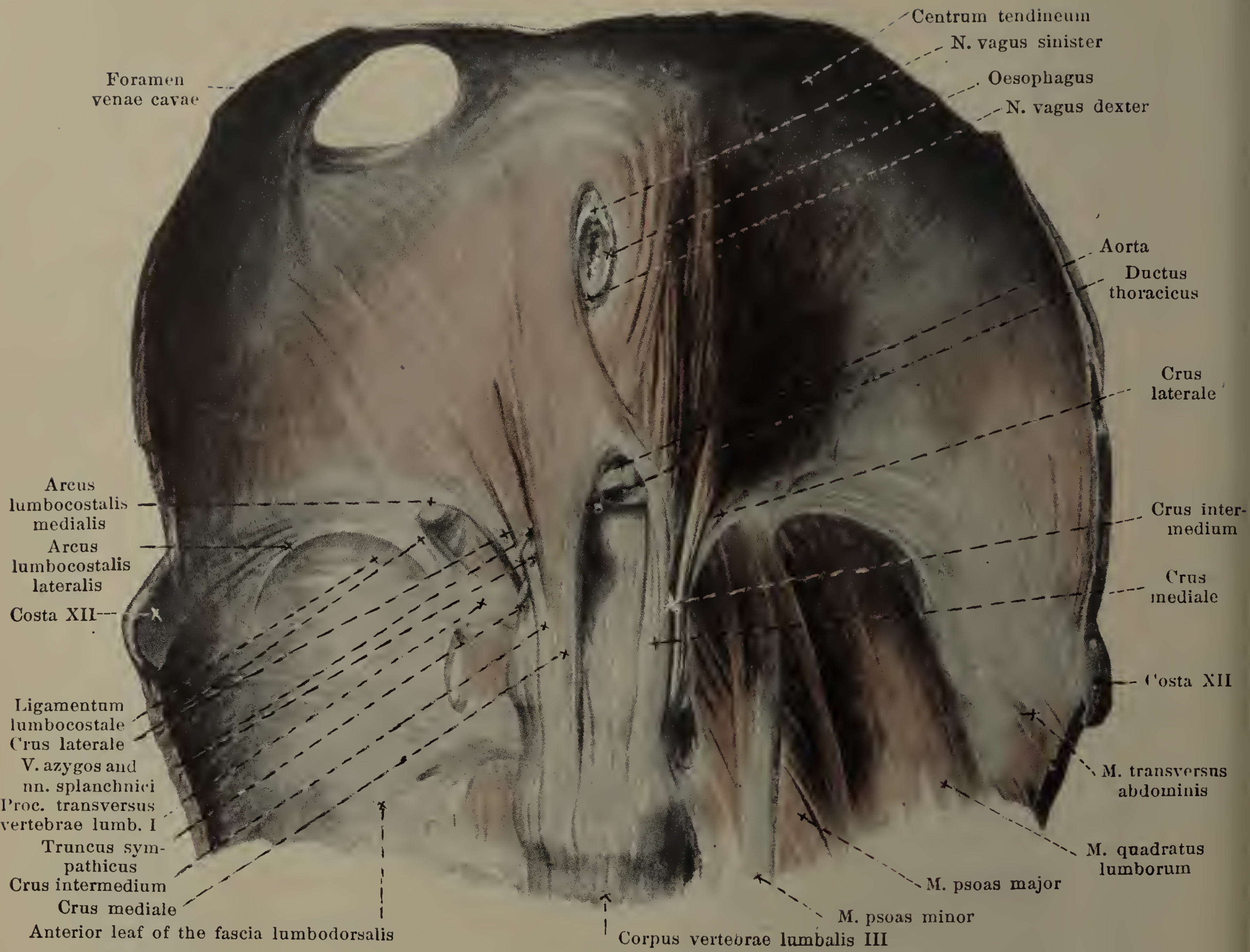
(On the right side the fibres of origin of the diaphragma have been removed.)


Foramen venae cavae
Pars sternalis diaphragmatis
Pars costalis diaphragmatis
Centrum tendineum
Hiatus oesophageus
Pars lumbalis diaphragmatis
Hiatus aorticus
Crus laterale diaphragmatis
Crus mediale diaphragmatis
Arcus lumbocostalis medialis
Arcus lumbocostalis lateralis
M. quadratus lumborum
M. transversus abdominis
M. obliquus internus abdominis
M. obliquus externus abdominis
M. iliacus
M. psoas major
M. psoas minor
Corpus vertebrae lumbalis V

365. Diaphragm, viewed from below and in front.

(The muscles of the chest have been removed, the abdominal muscles have been cut through transversely.)

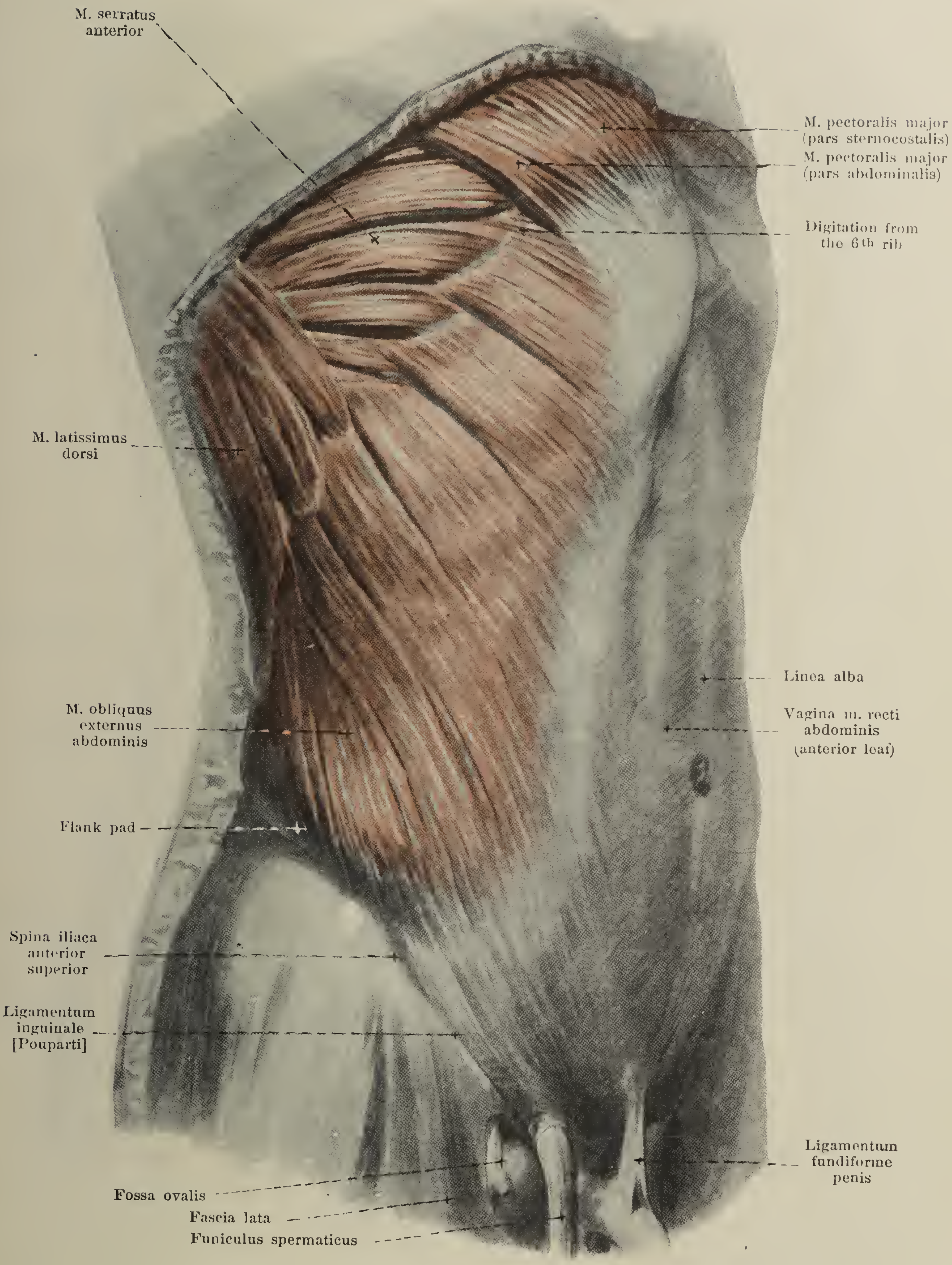
Diaphragma *(diaphragm)* (see also Figs. 364 and 366). Form and position: flat, broad, kidney-shaped, tendinous in the middle *(centrum tendineum)*, otherwise fleshy; it is stretched out transversely between the abdominal and thoracic cavities; it bulges into the thorax, being convex above, markedly so lateralward, less so in the middle, so that to the right and to the left there arises a cupola-like elevation, those of the two sides being separated by a shallow median depression; in the adult on moderate expiration the right cupola reaches to close below the costocartilaginous junction of the 4th rib, the left cupola to just above the costocartilaginous junction of the 5th rib (see Fig. 461). Origin: from the posterior surface of the proc. xiphoideus sterni *(pars sternalis)*, from the internal surface of the anterior ends of the 7th—12th rib *(pars costalis)* and from the lumbar vertebrae *(pars lumbalis)*.



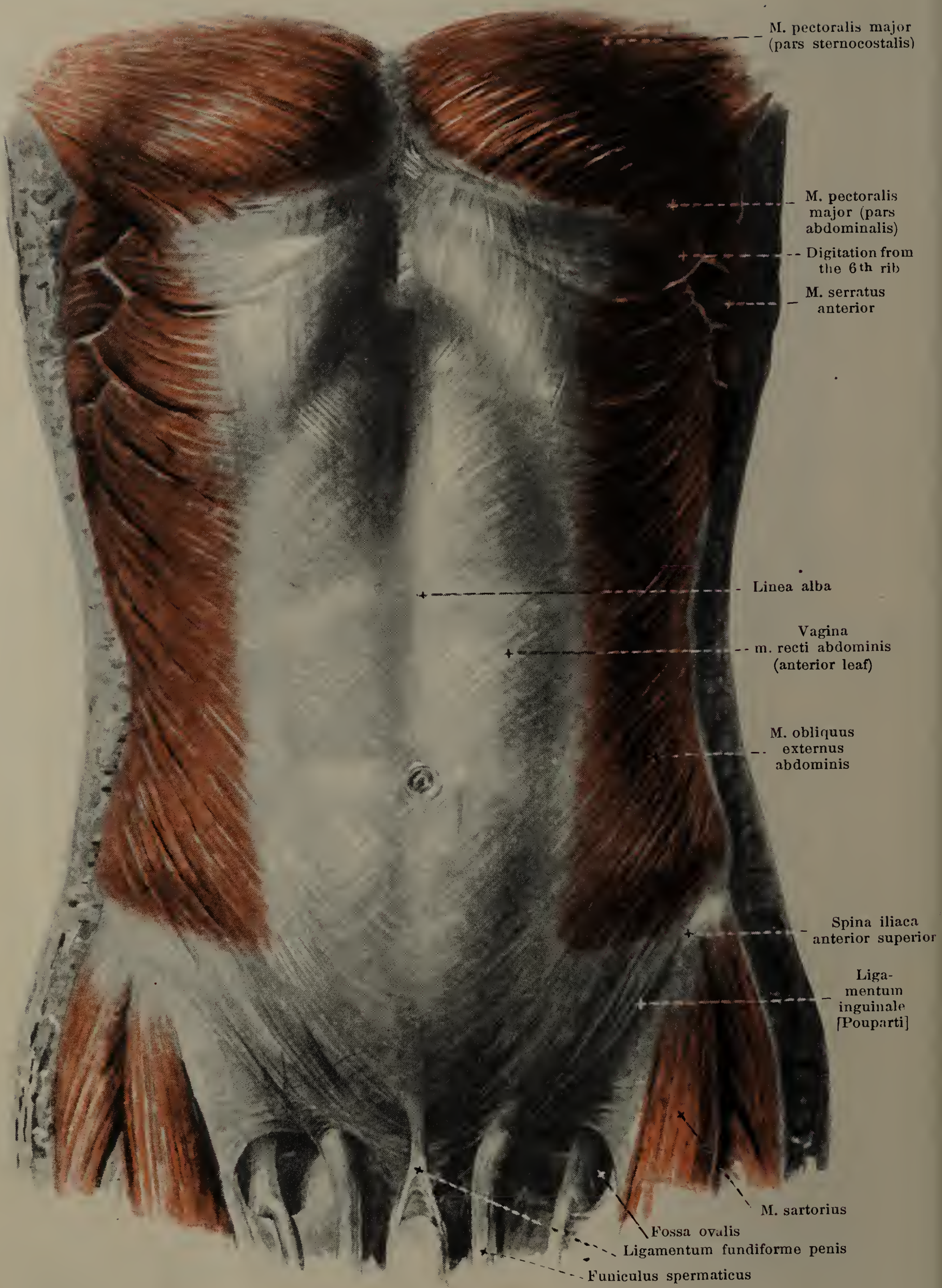
366. Diaphragm, pars lumbalis, viewed from below and in front.

(The diaphragm has been separated from the upper ribs and from the sternum and drawn somewhat upward; on the right the mm. psoas and quadratus lumborum have been removed.)

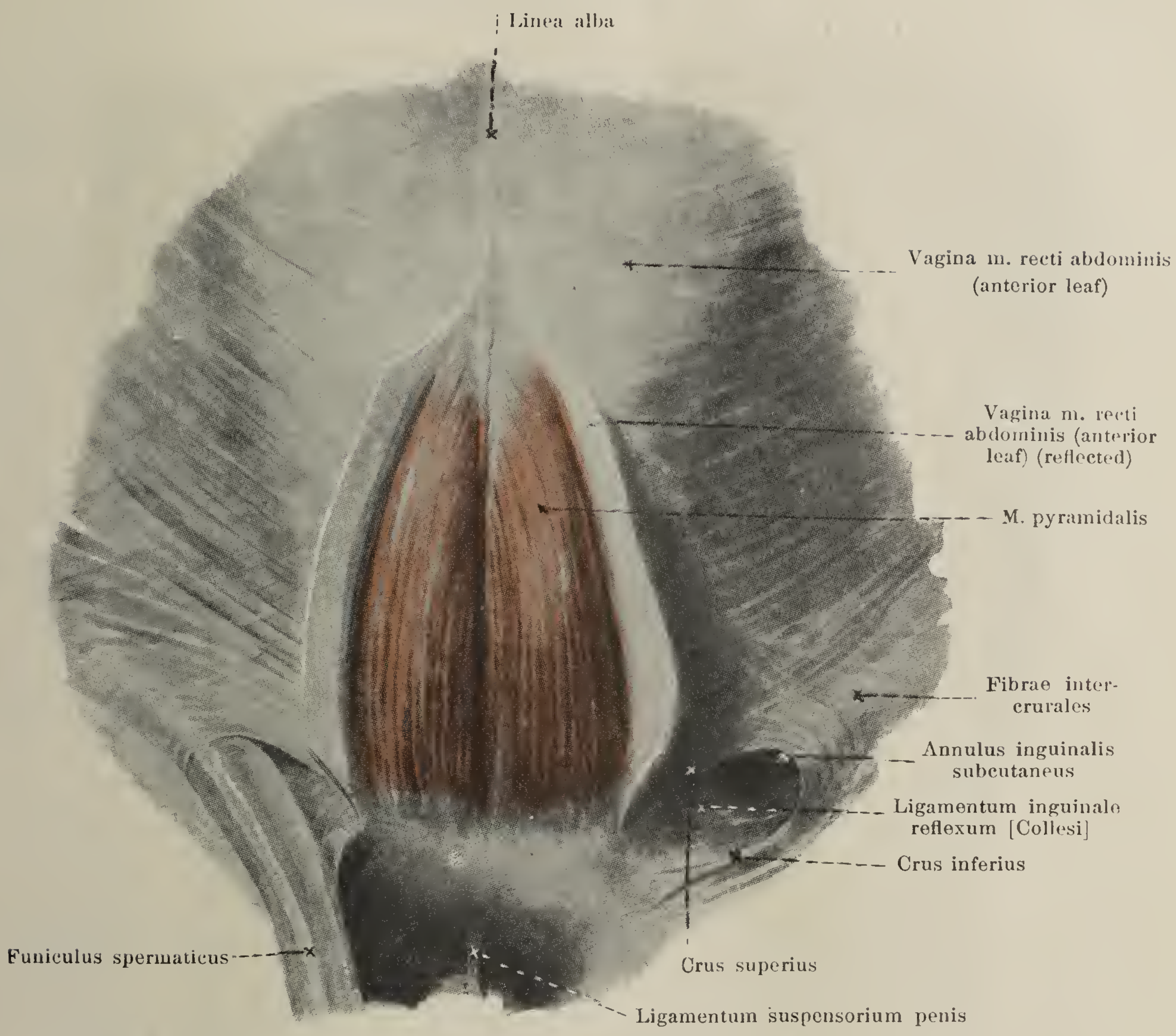
Diaphragma (continued). The pars lumbalis arises from the lig. longitudinale anterius and is divided on each side by perforating vessels and nerves (somewhat variably) into three *crura* (the rigth ones reaching a little farther down): *crus mediale*, on the rigth thicker, from the *crura* (the right reaching a little farther down); *crus mediale*, on the rigth thicker, from the anterior surface of the 3rd and 4th, *crus intermedium*, narrow, from the anterior surface of the 2nd and 3rd, *crus laterale*, from the lateral surface of the 2nd (or 1st) lumbar vertebral body and from a strip of fascia which extends thence in front of the m. psoas to the transverse process of the 1st lumbar vertebra and is fused with the fascia iliaca (see p. 343) *(arcus lumbocostalis medialis [Halleri])*. A second strip of fascia, between the point last mentioned and the 12th rib, *(arcus lumbocostalis lateralis [Halleri])*, forms a bridge over the m. quadratus lumborum and serves chiefly to give origin also to muscle fibres; a triangular space is frequentliy found over it in the muscle, *trigonum lumbocostale [Bochdaleki]*. The crura medialia of the two sides diverge somewhat above and in front and leave between them and the spine an oblong space, the *hiatus aorticus* (for the aorta and ductus thoracicus), which is closed before the centre of the 12th thoracic vertebral body by a small tendinous arch. Over this, the right crus mediale divides into two bundles which enclose a slit which reaches almost to the centrum tendineum, the *hiatus oesophageus* (for the oesophagus and the nn. vagi); the left crus mediale sends only a few corresponding fibres to the right. Between the crus mediale and the crus intermedium run usually the v. azygos (or hemiazygos) and the nn. splanchnici; between the crus intermedium and the crus laterale runs the truncus sympathicus. Insertion: on all sides radially to the *centrum tendineum* (O. T. central tendon), which has the shape of a clover-leaf or sometimes of a kidney and consists of interwoven tendon bundles. In its right half lies the *foramen venae cavae*, quadrangularly rounded (for the v. cava inferior). Action: it enlarges the thoracic cavity; the cupolae descend markedly, the centrum tendineum descends less. Innervation: nn. phrenici (C3, C4, C5).


M. serratus anterior
M. pectoralis major (pars sternocostalis)
M. pectoralis major (pars abdominalis)
Digitation from the 6th rib
M. latissimus dorsi
Linea alba
Vagina m. recti abdominis (anterior leaf)
M. obliquus externus abdominis
Flank pad
Spina iliaca anterior superior
Ligamentum inguinale [Pouparti]
Ligamentum fundiforme penis
Fossa ovalis
Fascia lata
Funiculus spermaticus

367. Muscles of the abdomen,
viewed from the right side and the front.


M. pectoralis major (pars sternocostalis)
M. pectoralis major (pars abdominalis)
Digitation from the 6th rib
M. serratus anterior
Linea alba
Vagina m. recti abdominis (anterior leaf)
M. obliquus externus abdominis
Spina iliaca anterior superior
Ligamentum inguinale [Pouparti]
M. sartorius
Fossa ovalis
Ligamentum fundiforme penis
Funiculus spermaticus

368. Muscles of the abdomen, viewed from in front.

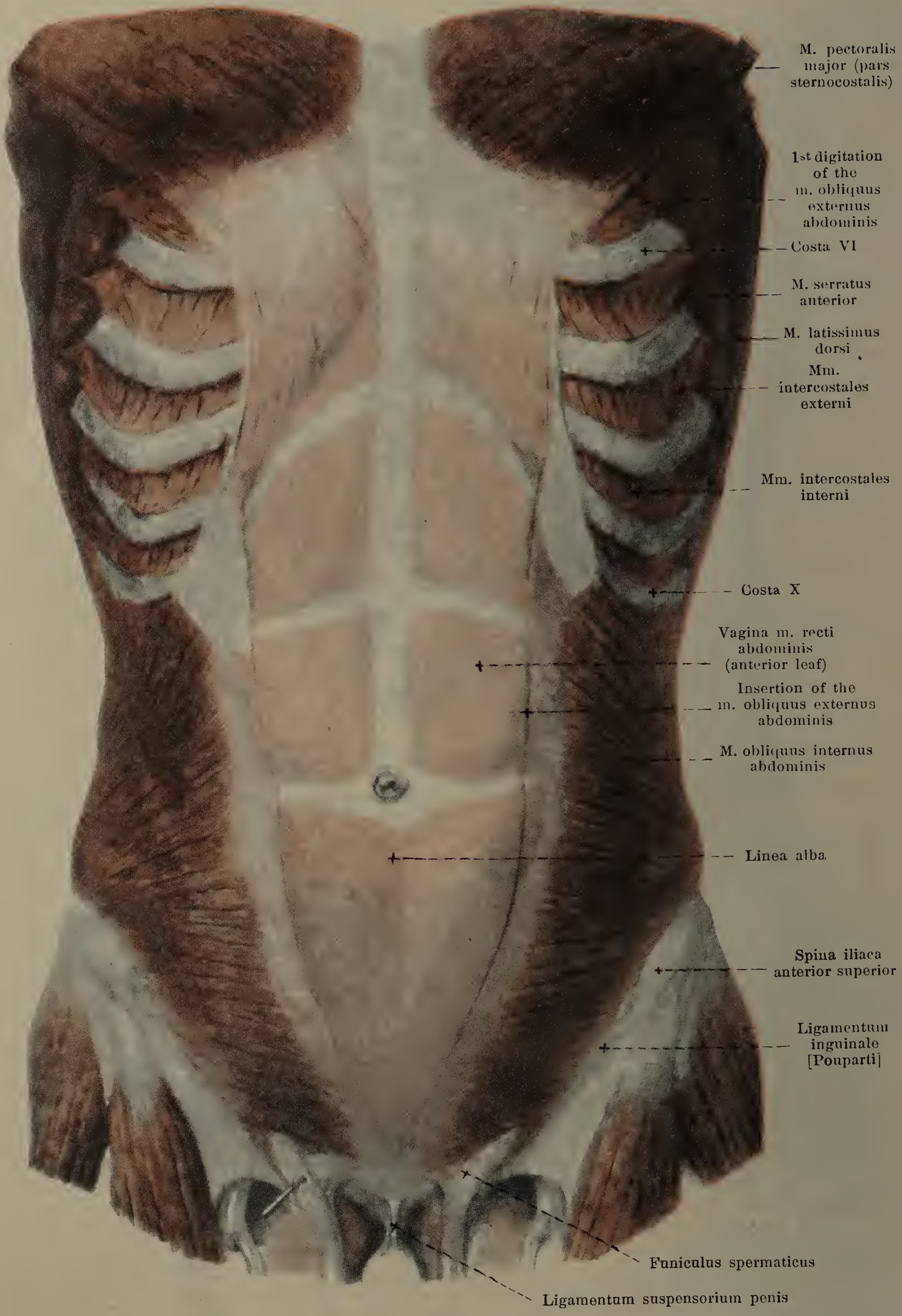

Linea alba
Vagina m. recti abdominis (anterior leaf)
Vagina m. recti abdominis (anterior leaf) (reflected)
M. pyramidalis
Fibrae intercrurales
Annulus inguinalis subcutaneus
Ligamentum inguinale reflexum [Collesi]
Crus inferius
Funiculus spermaticus
Crus superius
Ligamentum suspensorium penis

369. Mm. pyramidales, viewed from in front.

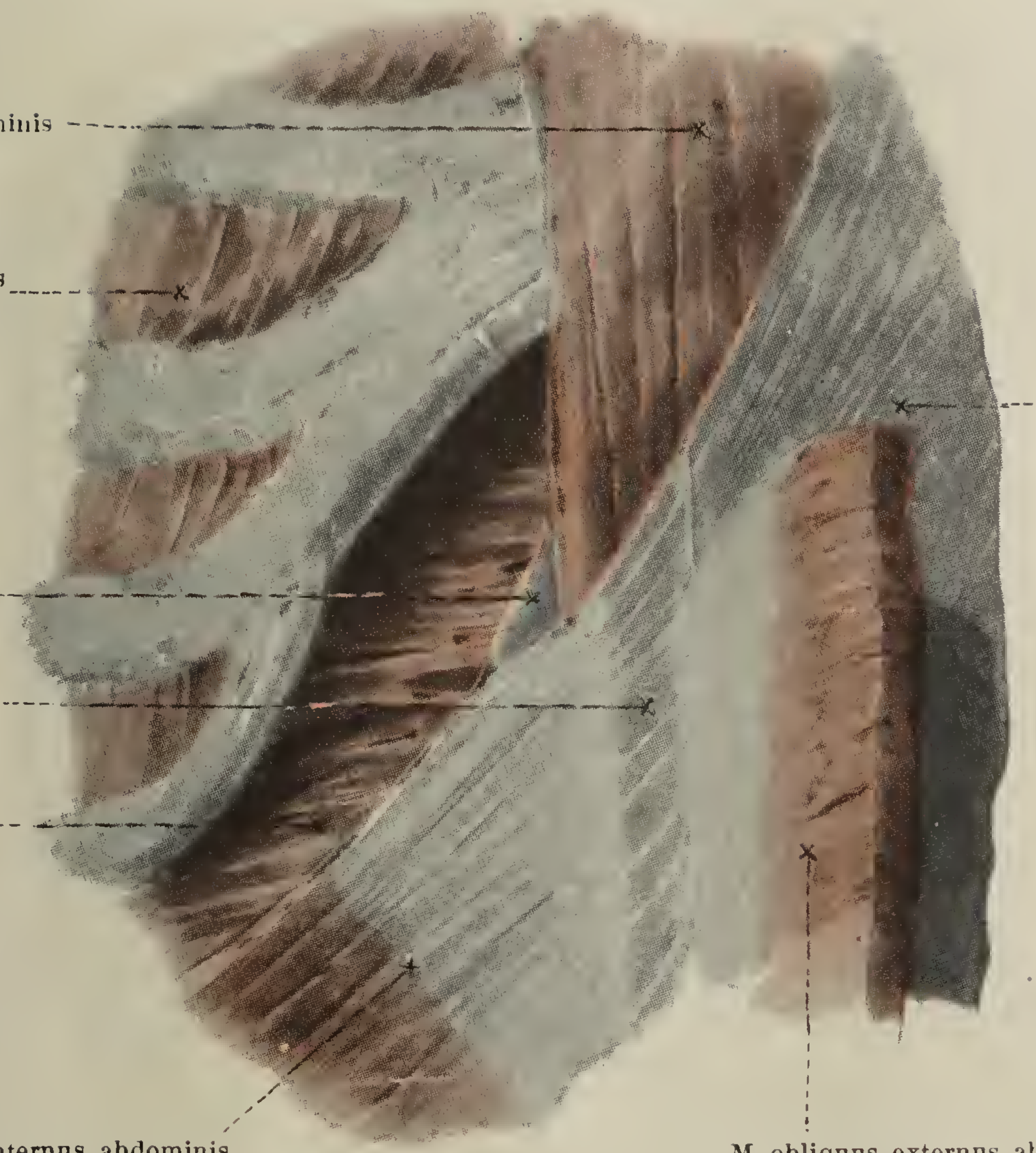
(The anterior leaf of the sheath of the rectus has been partially dissected off and reflected.)

M. obliquus externus abdominis (see also Figs. 367, 368, 380 and 382). Form: flat, quadrangular, broad, much longer in front than behind. Position: on the anterior and lateral surface of the abdominal and inferior thoracic region. Origin: by 8 fleshy digitations from the outer surface of the 12th—5th rib; the uppermost digitation is usually covered by the pars abdominalis m. pectoralis majoris (see Fig. 370); the 4 upper digitations are inserted between the digitations of the m. serratus anterior; the 3 lower between those of the m. latissimus dorsi. Insertion: the upper fibres run more transversely, forward, the lower more obliquely, forward and downward. The largest, upper part goes over medianward into a broad, tendinous sheath which runs in front of the m. rectus abdominis and helps to form the anterior leaf of the vagina m. recti abdominis (see p. 279). The next lower muscle bundles pass obliquely to the *ligamentum inguinale [Pouparti]* (O. T. Poupart's ligament) (see p. 298) and leave medianward an open space *(annulus inguinalis subcutaneus)* (see p. 298) for the passage of the funiculus spermaticus. The muscle fibres arising farthest back are attached in fleshy masses to the external lip of the iliac crest; they form, when the muscles are relaxed, a ridge (see Fig. 374) running in a horizontal direction *(flank pad)*, projecting slightly beyond the crista iliaca. Action: it draws the thorax downward (expiration); bends the spinal column forward and toward the same side and rotates it toward the other side; when the thorax is fixed it elevates the pelvis. Innervation: nn. intercostales V—XII and the nn. iliohypogastricus and ilioinguinalis (total Th_5—Th_{12} [L_1]).

M. pyramidalis, of variable degree of development, sometimes absent altogether. Form: flat, oblong-triangular. Position: close to the median plane above the symphysis pubis, in front of the m. rectus abdominis, in a duplicature of the anterior leaf of the vagina m. recti abdominis. Origin: anterior surface of the ramus superior ossis pubis and of the symphysis ossium pubis. Insertion: the fibres run upward and medianward to the linea alba. Action: it tightens the linea alba in the upright position and gives rise to a median groove below the navel when the abdominal muscles are relaxed. Innervation: n. intercostalis XII; possibly also fibres from L_1 and L_2 or only from these.


M. pectoralis major (pars sternocostalis)
1st digitation of the m. obliquus externus abdominis
Costa VI
M. serratus anterior
M. latissimus dorsi
Mm. intercostales externi
Mm. intercostales interni
Costa X
Vagina m. recti abdominis (anterior leaf)
Insertion of the m. obliquus externus abdominis
M. obliquus internus abdominis
Linea alba
Spina iliaca anterior superior
Ligamentum inguinale [Pouparti]
Funiculus spermaticus
Ligamentum suspensorium penis

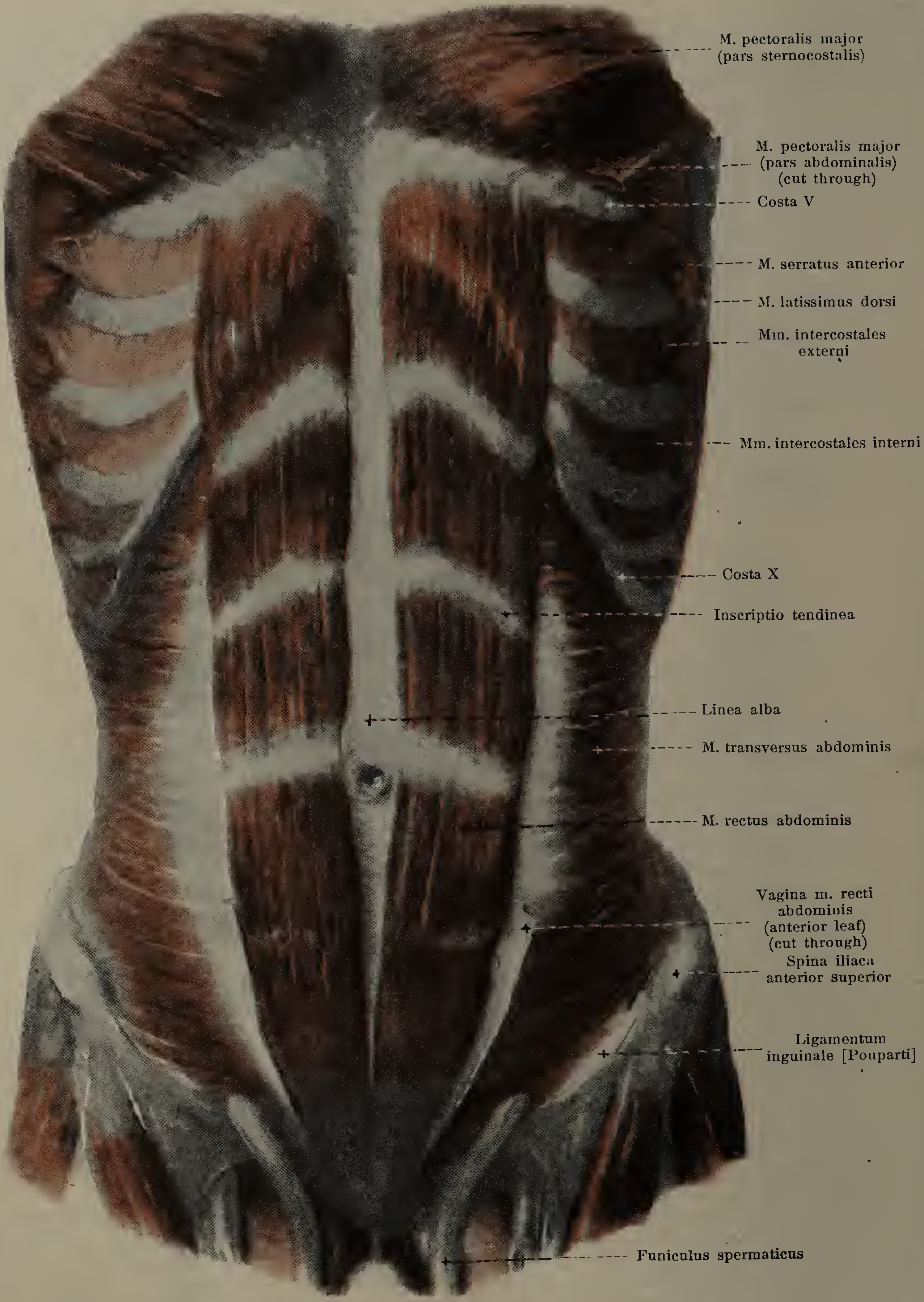
370. Muscles of the abdomen (2nd layer), viewed from in front.


M. rectus abdominis
Mm. intercostales interni
Vagina m. recti abdominis (anterior leaf)
Vagina m. recti abdominis
posterior leaf
anterior leaf
M. transversus abdominis
M. obliquus internus abdominis
M. obliquus externus abdominis (cut through and reflected medianward)

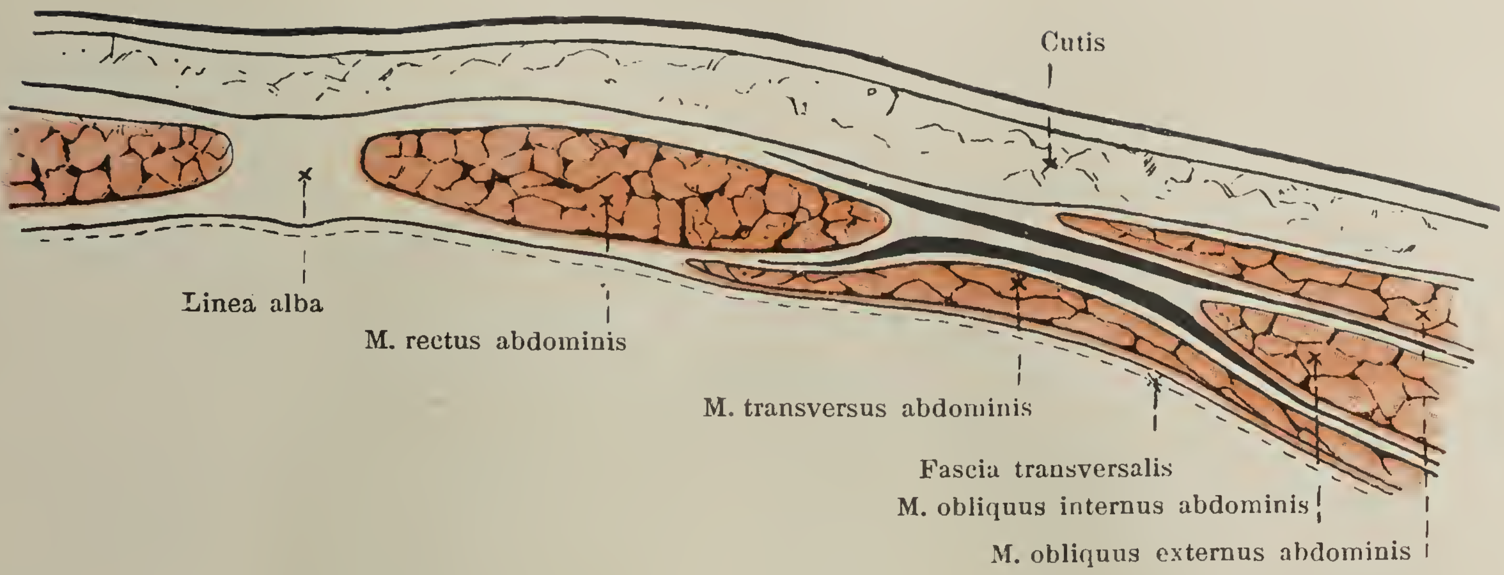
371. Transition of the tendon of the right m. obliquus internus abdominis into the sheath of the rectus.

(The m. obliquus externus abdominis has been completely removed above; below, it has been cut through and reflected; the m. obliquus internus abdominis has been separated at its upper border from the costal cartilages; the anterior leaf of the sheath of the rectus has been removed in the upper portion.)

M. obliquus internus abdominis (see also Figs. 370 and 382—384). Form: flat, quadrangular, broad, in front considerably longer than behind. Position: on the anterior and lateral surface of the abdomen, completely covered by the m. obliquus externus abdominis. Origin: posterior surface of the combined leaves of the fascia lumbodorsalis (see p. 306), linea intermedia of the iliac crest, lateral two thirds of the lig. inguinale (see p. 298). Insertion: the most posterior fibres pass upward and forward to the inferior margins of the 12th—10th rib. The other fibres coming from the iliac crest diverge and pass medianward so that the uppermost run parallel to the ends of the 10th—8th costal cartilages (connected with them only by loose tissue), the lowermost run transversely; the fibres from the lig. inguinale are somewhat curved as they run downward. All the muscle bundles not fastened to the ribs go over, lateralward from the m. rectus, along a curved line, into a tendinous plate. This divides in its upper two thirds into two lamellae, of which one passes in front of, the other behind, the m. rectus abdominis to go to the median plane and there form the basis for the corresponding leaf of the *vagina m. recti abdominis* (O. T. sheath of the rectus) (see also Fig. 373 and p. 297). In the lower third, all the fibres run in front of the m. rectus abdominis (see also Fig. 374 and p. 297); the posterior leaf of the rectal sheath is lacking here generally (see p. 297); its lower margin is curved so as to be concave and is called the *linea semicircularis [Douglasi]* (see Fig. 375 and p. 297). The lower margin of the muscle forms in part the upper wall of the inguinal canal (see p. 299); in addition the *m. cremaster* goes off from it (see p. 299). Action: the upper part draws the thorax downward (expiration), bends the spinal column forward and toward the same side, rotates it toward the same side; when the thorax is fixed it elevates the pelvis; the lower part acts in a similar manner to the m. transversus abdominis. Innervation: nn. intercostales X—XII and the nn. iliohypogastricus, ilioinguinalis and spermaticus externus (total [Th_{10}] Th_{11}, Th_{12}, L_1 [L_2]).

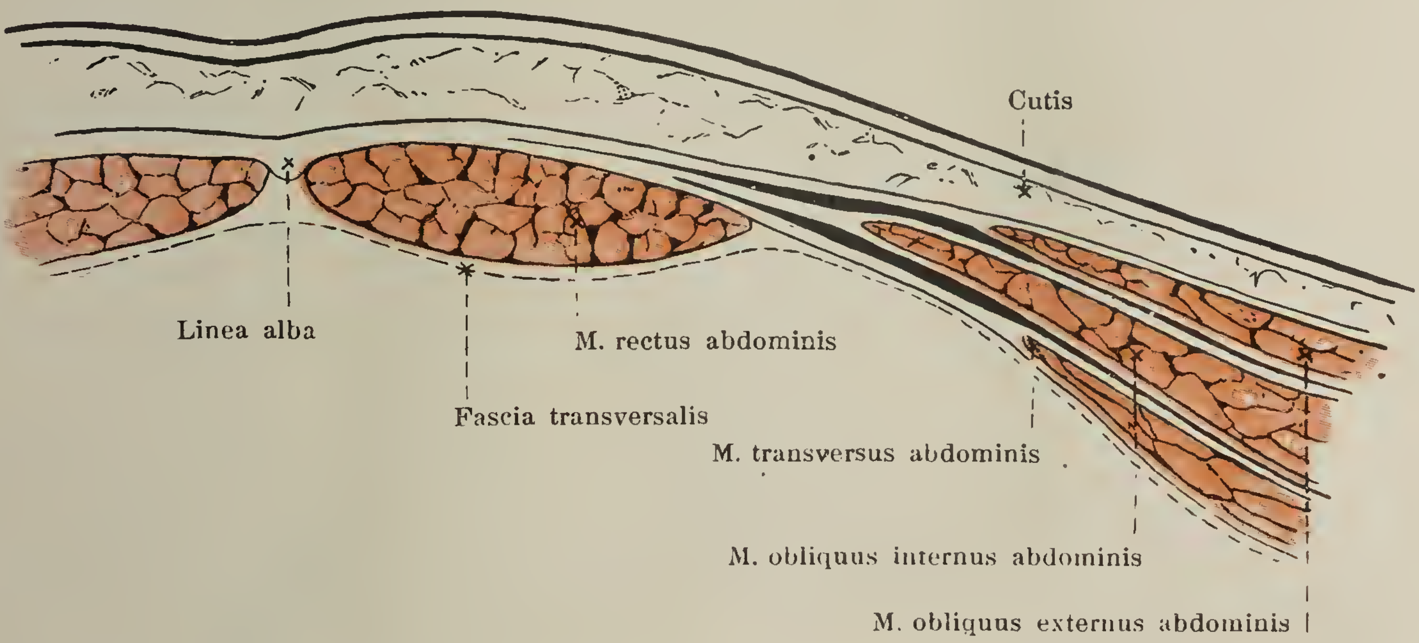

M. pectoralis major (pars sternocostalis)
M. pectoralis major (pars abdominalis) (cut through)
Costa V
M. serratus anterior
M. latissimus dorsi
Mm. intercostales externi
Mm. intercostales interni
Costa X
Inscriptio tendinea
Linea alba
M. transversus abdominis
M. rectus abdominis
Vagina m. recti abdominis (anterior leaf) (cut through)
Spina iliaca anterior superior
Ligamentum inguinale [Pouparti]
Funiculus spermaticus

372. **Mm. recti abdominis,** viewed from in front.



373. Transverse section through the abdominal wall above the linea semicircularis [Douglasi]

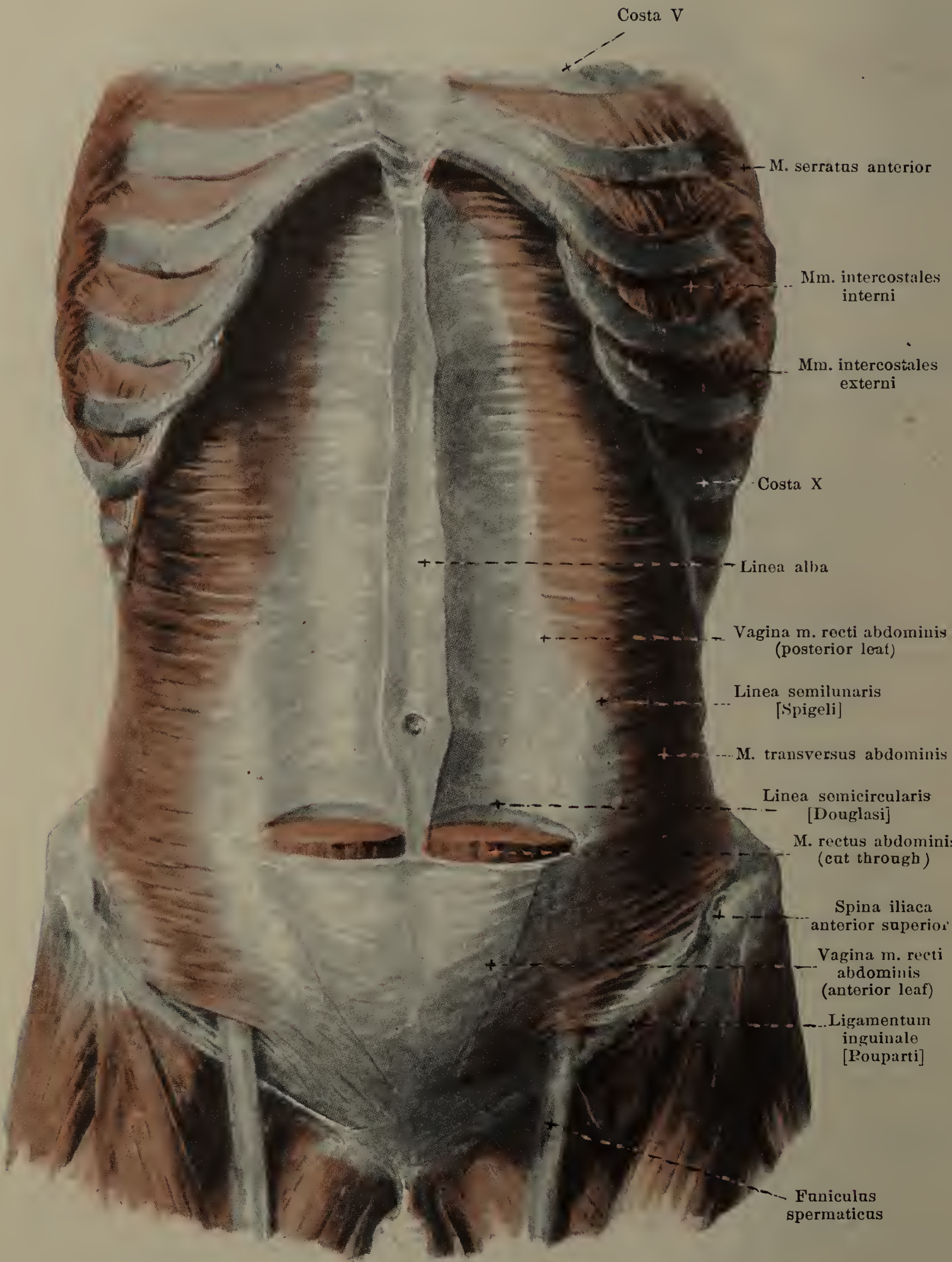
(after W. Braune).



374. Transverse section through the abdominal wall below the linea semicircularis [Douglasi]

(after W. Braune).

M. rectus abdominis (see Figs. 372 and 375). Form: flat, oblong-quadrangular, above broader and thinner, below narrower and thicker. Position: on the anterior surface of the abdomen close to the linea alba. In front it is covered by the anterior leaf of the vagina m. recti abdominis; behind it lies above immediately on the 6th—8th rib cartilage, below on the m. transversus abdominis and on the posterior leaf of the vagina m. recti, in the lower third where the latter is lacking, directly upon the fascia transversalis. Origin: anterior surface of the 5th—7th costal cartilage, of the proc. xiphoideus and of the lig. costoxiphoideum. Insertion: its fibres run downward, parallel to one another. In its upper half it is interrupted by three intercalated tendons, *inscriptiones tendineae;* the uppermost, usually incomplete, goes slightly arch-shaped at the level of the horizontal part of the 8th costal cartilage, the lowermost runs transversely at the level of the navel, and the middle one, between these two, in a similar direction; these intermediate tendons often do not go entirely through the thickness of the muscle; they are very intimately connected with the anterior leaf, but loosely with the posterior leaf of the rectal sheath. The number and extent of these tendons varies; usually there is an incomplete one in the lateral half of the muscle below the navel at the level of the linea semicircularis [Douglasi]. Below, the muscle fibres converge and are attached by a strong flat tendon to the ramus superior oss. pubis and to the anterior surface of the symphysis ossium pubis; the fibres of the tendons are there very much interwoven. Action: it draws the thorax downward (expiration) and bends the spinal column forward; when the thorax is fixed it elevates the pelvis. Single sections of the muscle can contract separately. Innervation: nn. intercostales VI—XII.


Costa V
M. serratus anterior
Mm. intercostales interni
Mm. intercostales externi
Costa X
Linea alba
Vagina m. recti abdominis (posterior leaf)
Linea semilunaris [Spigeli]
M. transversus abdominis
Linea semicircularis [Douglasi]
M. rectus abdominis (cut through)
Spina iliaca anterior superior
Vagina m. recti abdominis (anterior leaf)
Ligamentum inguinale [Pouparti]
Funiculus spermaticus

375. Muscles of the abdomen (3rd layer),
viewed from in front.

(Mm. obliqui abdominis have been completely removed; furthermore on each side the m. rectus abdominis and the anterior leaf of its sheath have been removed on each side in their upper two thirds.)

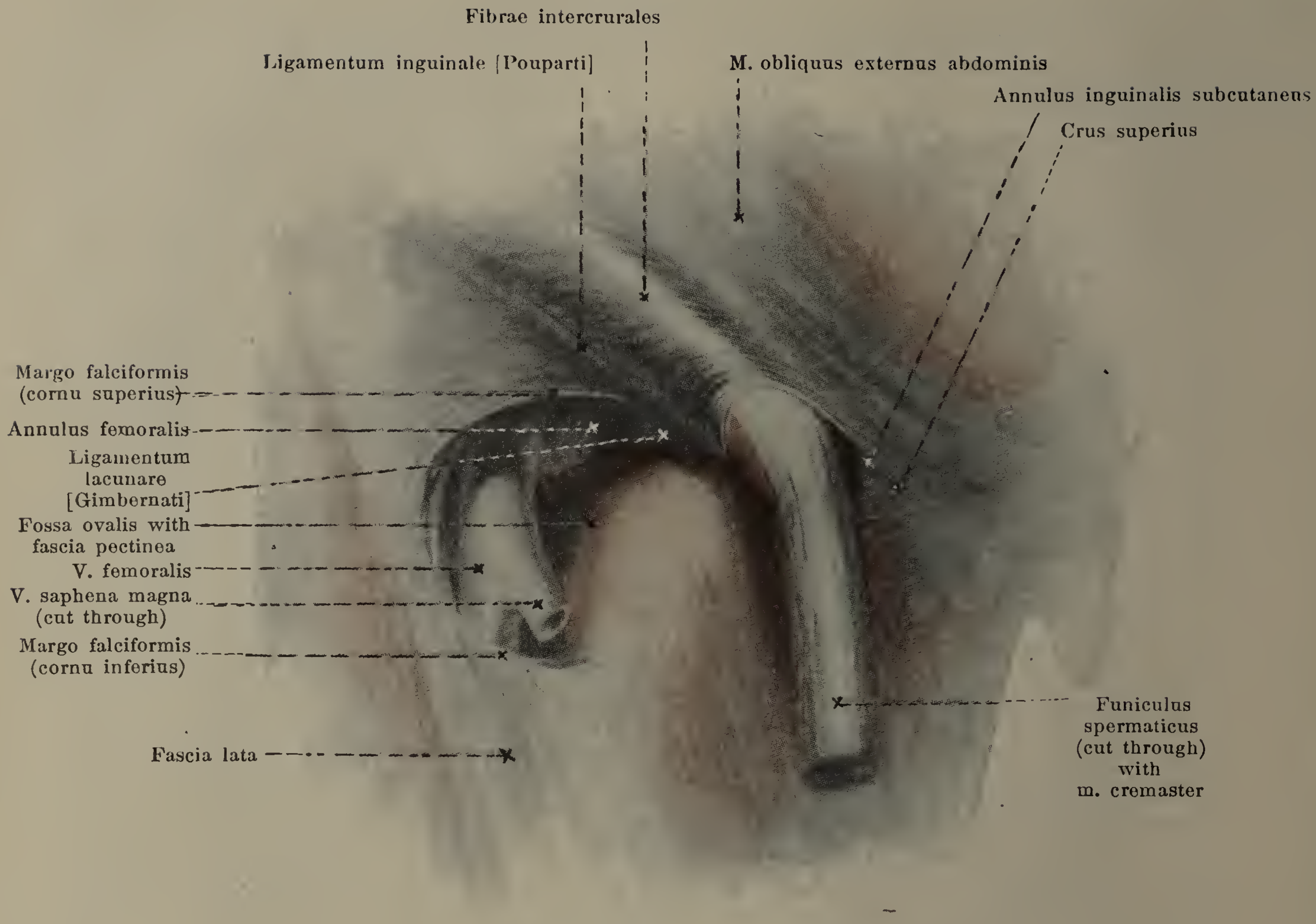
M. transversus abdominis (see also Figs. 364, 372 and 383). Form: flat, quadrangular, broad, much longer in front than behind. Position: on the anterior and lateral surface of the abdomen, completely covered by the mm. obliqui abdominis, partly also by the m. rectus abdominis. The muscle fibres which arise from the 7th and 8th rib lie entirely behind the m. rectus abdominis. Origin: from the internal surfaces of the 7th—12th costal cartilage, from the union of the two leaves of the fascia lumbodorsalis (see Figs. 383 and 384), from the internal lip of the iliac crest and from the lateral two thirds of the lig. inguinale (see p. 298). Insertion: the fibres are parallel, run transversely forward and go over into a tendon plate along a line which is concave medianward *(linea semilunaris [Spigeli])*. This tendon plate (see also Figs. 373 and 374) runs, in its upper two thirds, behind the m. rectus abdominis and strengthens the posterior leaf of the sheath of the rectus; in the lower third, where there is no posterior leaf of the rectal sheath (see below), it goes in front of the m. rectus abdominis and fuses with the anterior leaf of the rectal sheath; some bundles may run there also behind the m. rectus. The lowermost fibres arch downward and help to form the posterior wall of the inguinal canal (see pag. 300); they are attached partly to the upper surface of the os pubis, partly to the lig. inguinale. Action: it pulls the ribs downward (expiration) and diminishes the size of the abdominal cavity. Innervation: nn. intercostales V—XII, the nn. iliohypogastricus, ilioinguinalis and spermaticus externus (total [Th_5] Th_{12}, L_1, L_2).

Vagina m. recti abdominis ***(sheath of the rectus)*** (see also Figs. 368, 370, 371, 373 and 374) consists on each side of two broad tendinous leaves, which cover directly the anterior and posterior surfaces of the m. rectus abdominis and which are formed by the tendons of the mm. obliqui et transversus abdominis; medianward both leaves meet those of the other side in the linea alba. The anterior leaf covers the whole anterior surface of the m. rectus and is firmly fused with its inscriptiones tendineae. It is very thin above and there serves to give origin to the pars abdominalis of the m. pectoralis major; it becomes stronger lower down and consists of interwoven fibres. In its upper two thirds it is formed by the anterior leaf of the tendon of the m. obliquus internus and the tendon of the m. obliquus externus (see Fig. 373) fused with it, in its lower third by the union of the tendons of the mm. obliqui and of the m. transversus abdominis (see Figs. 374 and 375). The posterior leaf is much shorter, begins on the costal cartilages at the angulus infrasternalis and ends as a stiff membrane, more or less sharply, somewhat below the navel in a margin, the *linea semicircularis [Douglasi]*, which is concave below and stretches out lateralward from the linea alba; it consists of the transverse tendinous fibres of the posterior leaf of the tendon of the m. obliquus internus abdominis and those of the m. transversus abdominis. The posterior leaf more or less thinned and formed only by fibres of the m. transversus, extends frequently further downwards and rarely reaches to the upper edge of the symphysis, leaving a gap only for the passage of the vasa epigastrica inferiora.

Linea alba (see also Figs. 368, 369 and 372— 374) is a tough connective tissue strip which extends in the median plane between the mm. recti abdominis from the proc. xyphoideus to the symphysis ossium pubis. Below the proc. xyphoideus it gradually broadens, being about twice as wide at the level of the navel as it is higher up, and again narrows below the navel to a thin cord which is attached behind the tendons of the mm. recti abdominis to the lig. pubicum superius by means of a triangular expansion *(adminiculum lineae albae)* (see Fig. 379). The sheath of the rectus is attached to the linea alba; indeed it forms it, in a way, through the union of the two leaves of the right side with the two leaves of the left. Approximately below its middle and about at the level of the body of the 4th lumbar vertebra the linea alba contains the navel, *umbilicus;* individually its position changes to no small degree.

Ligamentum fundiforme penis (O. T. suspensory ligament) (see Figs. 367 and 368) (in the male) is a broad band, consisting essentially of elastic fibres; it arises, above the symphysis ossium pubis, from the anterior surface of the vagina m. recti and the linea alba as well as from the fascia superficialis abdominis. It surrounds the penis like a loop by means of its two limbs and often radiates out into the scrotum.

Ligamentum fundiforme clitoridis (O. T. suspensory ligament) (see also Fig. 728) (in the female) correspond sto the ligamentum fundiforme penis.

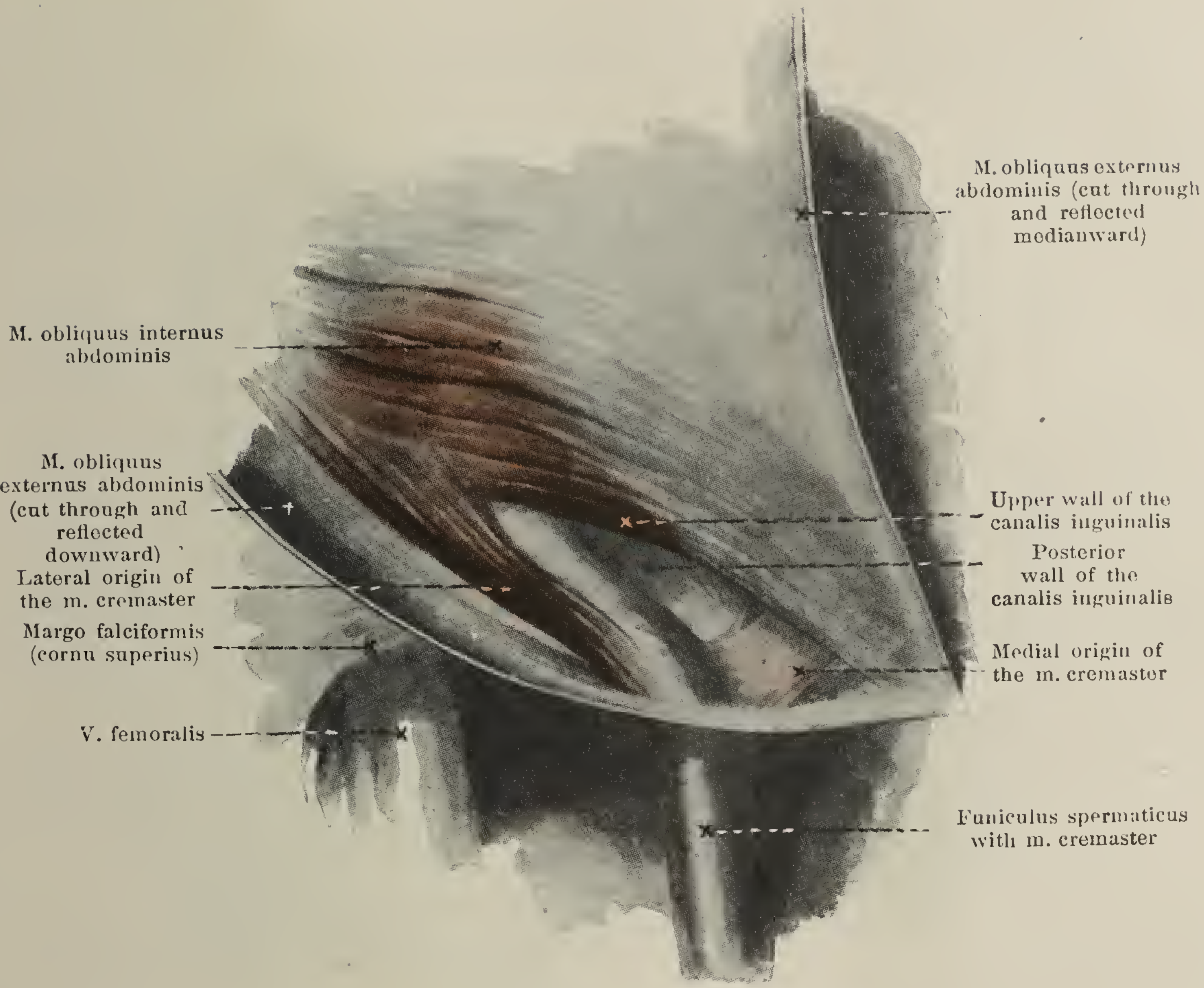

Fibrae intercrurales
Ligamentum inguinale [Pouparti]
M. obliquus externus abdominis
Annulus inguinalis subcutaneus
Crus superius
Margo falciformis (cornu superius)
Annulus femoralis
Ligamentum lacunare [Gimbernati]
Fossa ovalis with fascia pectinea
V. femoralis
V. saphena magna (cut through)
Margo falciformis (cornu inferius)
Fascia lata
Funiculus spermaticus (cut through) with m. cremaster

376. Right anterior abdominal ring and fossa ovalis in the male.

Ligamentum inguinale [Pouparti] (O. T. Poupart's ligament) (see also Figs. 367, 368, 375, 379, 421 and 427) is a powerful, flatly rounded tendon, which extends from the spina iliaca anterior superior to the tuberculum pubicum and can be palpated through the skin as a hard cord. It is not an independent ligament but formed medially by the tendinous fibres of the m. obliquus externus, laterally by that of both mm. obliqui and the m. transversus abdominis; to its lower margin the fascia lata is attached and this causes a convex downward bulging of the ligament. Medianward the ligament does not end at the tuberculum pubicum alone, but also sends diverging fibres to the pecten ossis pubis; the latter insertion is a small triangular ligament, *ligamentum lacunare [Gimbernati]* (O. T. Gimbernat's ligament) (see also Fig. 379 and 421), which is fused with the fascia pectinea, extends obliquely backward and upward and with its lateral concave margin bounds the annulus femoralis (see p. 343).

Canalis inguinalis *(inguinal canal)* (see also Figs. 369 and 377—379) is a cylindrical space filled up completely by the ductus deferens (in the male, by the lig. teres uteri in the female) with the accompaning vessels (see p. 607 and 619); it perforates the lowermost portion of the abdominal muscles obliquely from behind and above, forward, downward and medianward. The canal has two openings, one posterior, *annulus inguinalis abdominalis* (O T. internal abdominal ring), and one anterior, *annulus inguinalis subcutaneus* (O. T. external abdominal ring), and (somewhat schematically) four walls, one anterior, one inferior, one superior, one posterior. It is narrower in the female, but somewhat longer than in the male.

The ***annulus inguinalis subcutaneus*** (see also Fig. 369) lies somewhat laterally from and a little above the tuberculum pubicum. It is formed by the separation of the lowermost fibres of the tendon of the m. obliquus externus from one another giving rise to an acute-angled space, which is bounded below by fibres which go the tuberculum pubicum *(crus inferius.* O. T. external pillar), above by fibres which run to the anterior surface of the symphysis ossium pubis *(crus superius.* O. T. internal pillar); the larger lateral portion of the space is filled up by curved fibres which run transversely, *fibrae intercrurales* (O. T. intercolumnar fascia, external spermatic fascia.) These fibres leave as a free opening only a small space, convex laterally, which will permit the passage of the tip of the index finger.


M. obliquus externus abdominis (cut through and reflected medianward)
M. obliquus internus abdominis
M. obliquus externus abdominis (cut through and reflected downward)
Lateral origin of the m. cremaster
Margo falciformis (cornu superius)
V. femoralis
Upper wall of the canalis inguinalis
Posterior wall of the canalis inguinalis
Medial origin of the m. cremaster
Funiculus spermaticus with m. cremaster

377. Right inguinal canal in the male (2nd layer), viewed from in front.

(The m. obliquus externus abdominis has been cut through above the anterior abdominal ring and reflected partly medianward and partly downward. The spermatic cord has been pressed somewhat downward within the inguinal canal.)

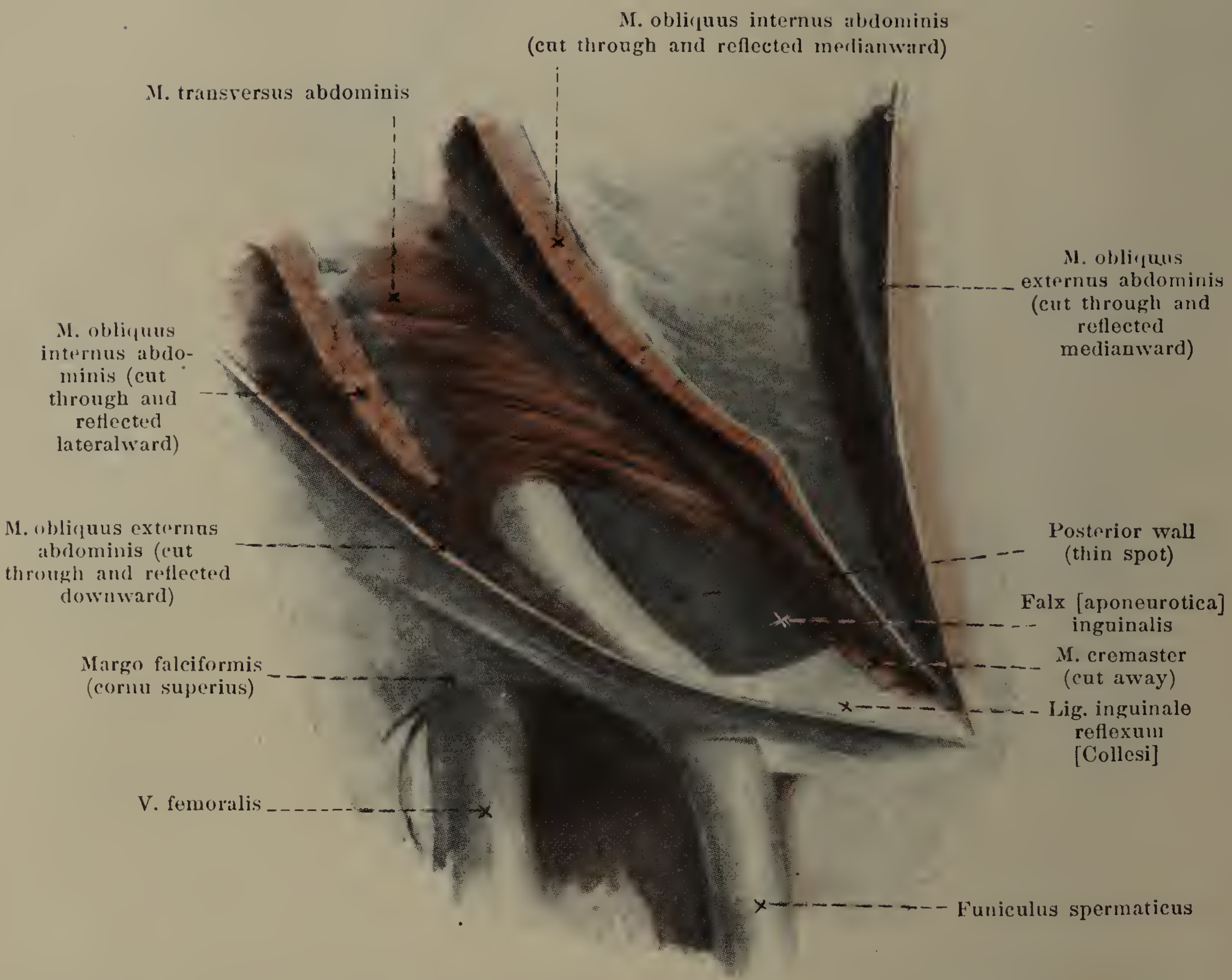
Canalis inguinalis (continued) (see also Figs. 369, 376, 378 and 379).

Anterior wall: formed by the tendon plate of the m. obliquus externus abdominis, especially also by the fibrae intercrurales.

Lower wall: m. obliquus externus; the lig. inguinale [Pouparti] and the fibrous bands of the crus inferius immediately adjacent do not extend in their medial portion in a straight line to the tuberculum pubicum but are curved somewhat downward so that they form a groove open above for the spermatic cord.

Upper wall: m. obliquus internus; the lowermost fibres of this muscle, arising from the lig. inguinale, extend in curves medianward and downward, forming lateralward the muscular, narrow, upper wall of the inguinal canal and going over medianward into the anterior layer of the sheath of the rectus; this medial part has its lower insertion sometimes farther lateralward and then passes close in front of and along with the falx inguinalis to the upper surface of the os pubis.

M. cremaster (see also Figs. 376 and 705) (in the male). It arises by a thick lateral bundle in continuation of the lowermost fibres of the mm. obliquus internus and transversus abdominis from the upper margin of the lig. inguinale and by a weak, medial bundle from the anterior layer of the sheath of the rectus; the former lies on the lateral, the latter on the medial surface of the spermatic cord; both pass with the spermatic cord through the subcutaneous opening of the inguinal canal, spread out in common upon the tunica vaginalis communis of the testis and epididymis, and surround it like bows, forming also a long-meshed net. Action: it elevates the testis. Innervation: n. spermaticus externus (L_2 or L_1, L_2). — In the female this muscle consists of only a few fibres which go to the lig. teres uteri.

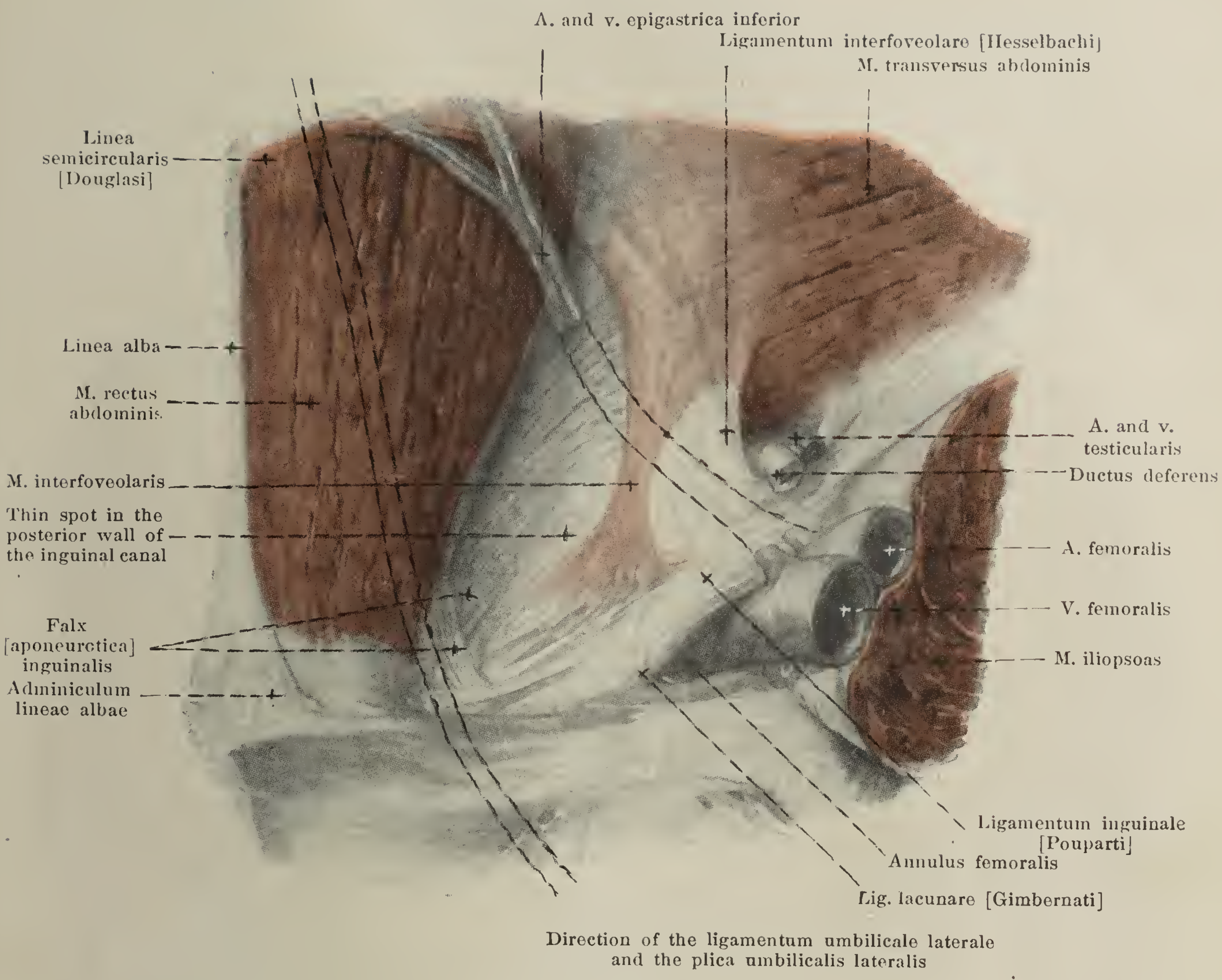

M. obliquus internus abdominis (cut through and reflected medianward)
M. transversus abdominis
M. obliquus externus abdominis (cut through and reflected medianward)
M. obliquus internus abdominis (cut through and reflected lateralward)
M. obliquus externus abdominis (cut through and reflected downward)
Posterior wall (thin spot)
Falx [aponeurotica] inguinalis
M. cremaster (cut away)
Margo falciformis (cornu superius)
Lig. inguinale reflexum [Collesi]
V. femoralis
Funiculus spermaticus

378. Right inguinal canal in the male (3rd layer), viewed from in front.

(The mm. obliqui abdominis have been cut through above the inguinal canal and reflected medianward and lateralward. The spermatic cord has been pressed somewhat downward within the inguinal canal.)

Canalis inguinalis (continued). Posterior wall (see also Fig. 379): m. transversus; the lowermost fibres of the m. transversus arch downward on the median side of the posterior abdominal ring, spread out in a divergent manner and become attached medianward to the upper surface of the os pubis, lateralward to the upper margin of the lig. inguinale. The approximately triangular plate thus arising forms the posterior wall of the inguinal canal and varies in strength at different places. Medianward it contains a strip of strong tendinous fibres, *falx [aponeurotica] inguinalis*, which extends from above downward and medianward to the upper surface of the os pubis, and becomes firmly attached by its medial border to the tendon of the m. rectus; in front it is not rarely covered and strengthened by tendon fibres of the m. obliquus internus (see p. 299). In the lowermost portion of this strip there are also tendon fibres which extend from the lateral margin of the m. rectus abdominis, in curves, downward and lateralward (see Fig. 379); not seldom they are more powerful than the others. The lateral part of the posterior wall is strengthened by the lig. interfoveolare (see p. 301).

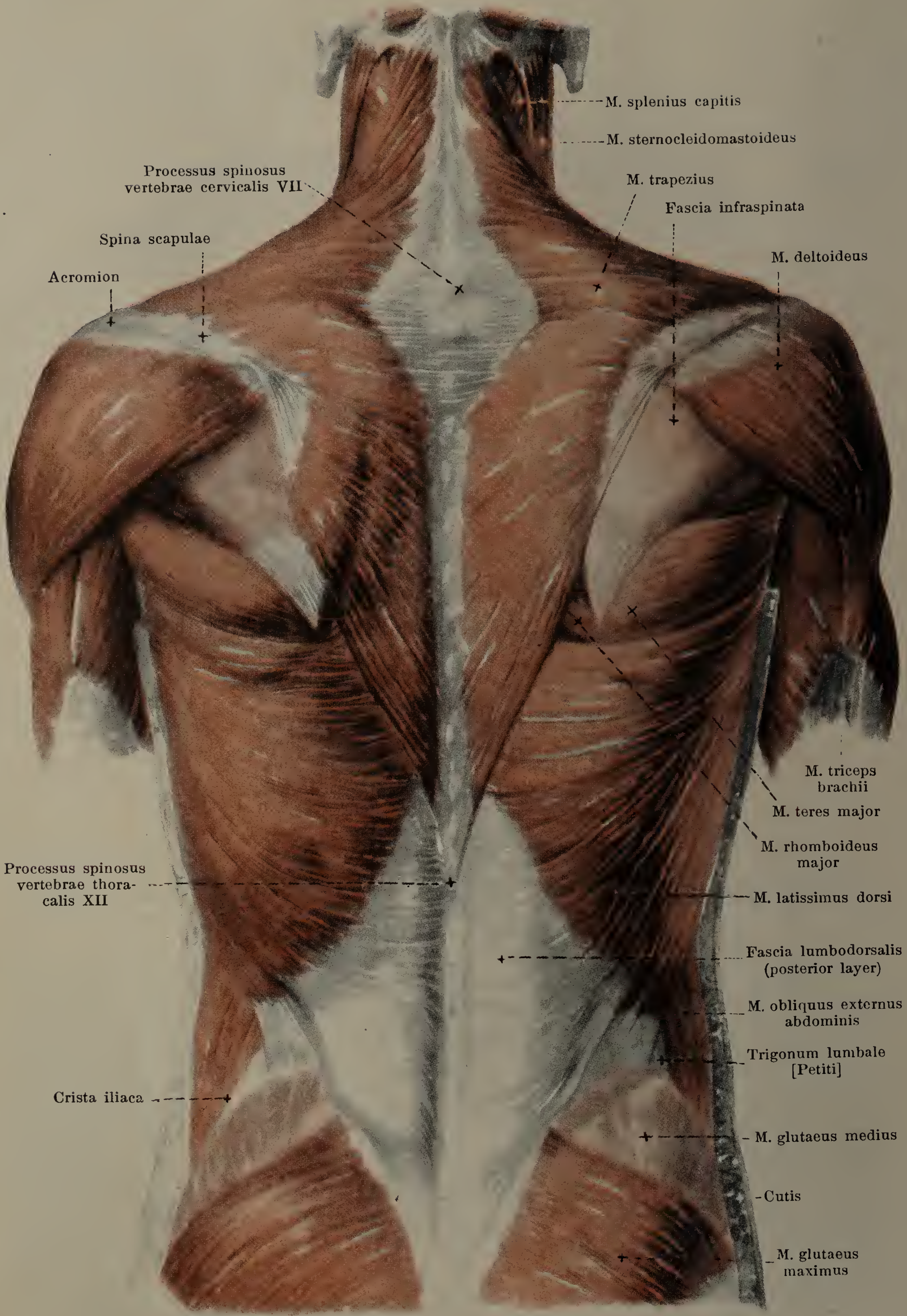
The *ligamentum inguinale reflexum [Collesi]* (see also Fig. 369) is a thin band of fibres, one finger broad, which comes into view medial from the annulus inguinalis subcutaneus, between the two crura. It extends from the medial end of the lig. inguinale and lig. lacunare obliquely upward and medianward behind the crus superius to the anterior layer of the sheath of the rectus and in so doing lies partly in front of the lowermost portion of the falx inguinalis, partly it connects with fibres of the m. obliquus externus of the other side.


A. and v. epigastrica inferior
Ligamentum interfoveolare [Hesselbachi]
M. transversus abdominis
Linea semicircularis [Douglasi]
Linea alba
M. rectus abdominis
M. interfoveolaris
Thin spot in the posterior wall of the inguinal canal
Falx [aponeurotica] inguinalis
Adminiculum lineae albae
A. and v. testicularis
Ductus deferens
A. femoralis
V. femoralis
M. iliopsoas
Ligamentum inguinale [Pouparti]
Annulus femoralis
Lig. lacunare [Gimbernati]
Direction of the ligamentum umbilicale laterale and the plica umbilicalis lateralis

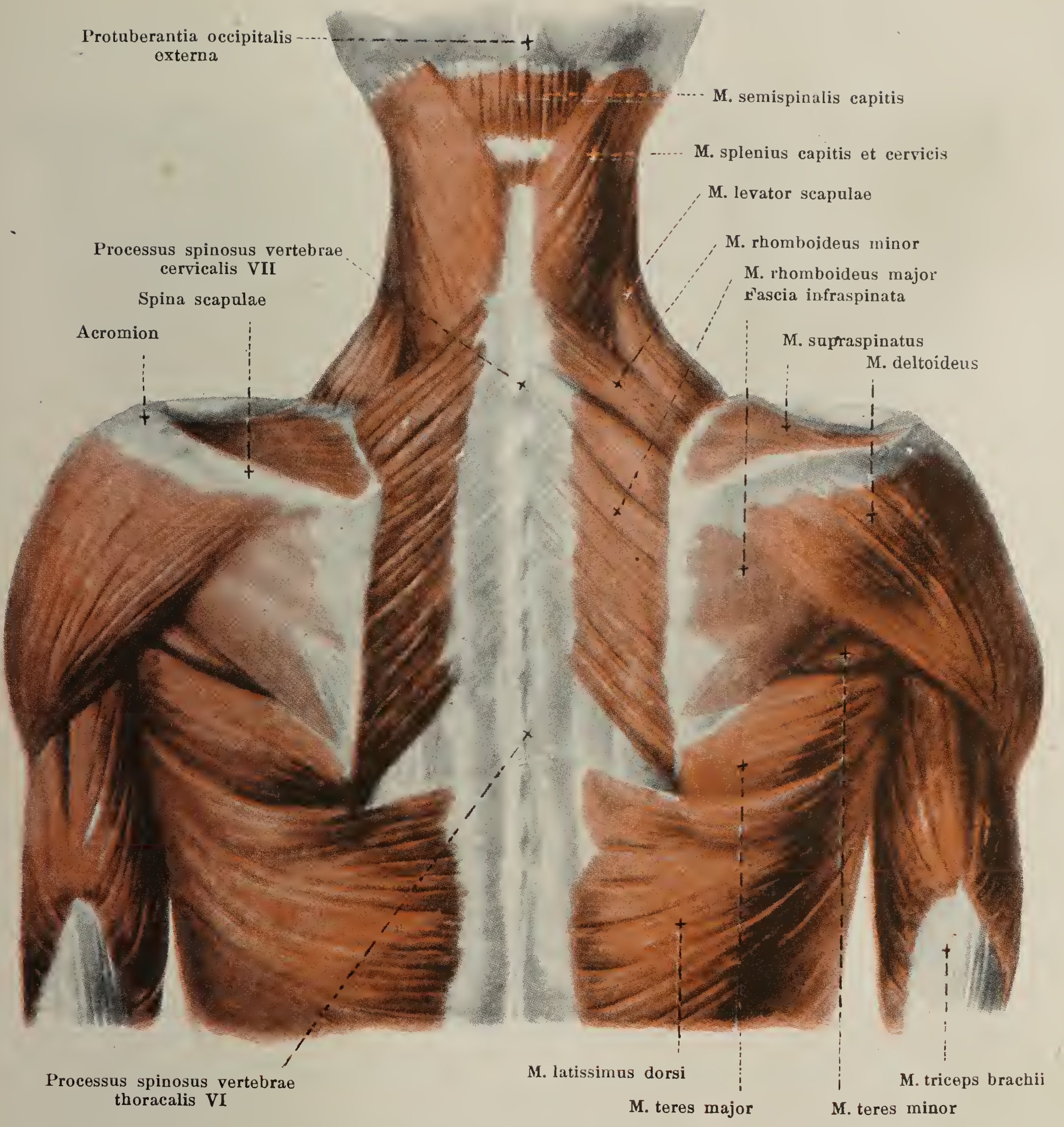
379. Posterior wall of the right inguinal canal in the male, viewed from behind.

Canalis inguinalis (continued). Posterior wall (continued): The lateral part of the plate connected with the m. transversus, which forms the posterior wall (see p. 300), is strengthened laterally by a band of fibres markedly concave lateralward and upward, the *ligamentum interfoveolare [Hesselbachi]*. This lies just in front of the a. epigastrica inferior. It consists of fibres which bend directly downward from the m. transversus and of those which go off behind the same farther up; both kinds of fibres extend downward, bend around chiefly lateralward and upward, partly also medianward and downward to the inner surface of the lig. inguinale and fuse with it. The falx inguinalis and the lig. interfoveolare vary greatly in strength and breadth. The thinner spot, situated between the two, which lies directly behind the subcutaneous abdominal ring, is broad, when they are narrow, and vice versa; it contains always single tendon fibres of the m. transversus, consists otherwise of irregularly and loosely arranged fibres, and is perforated by the a. spermatica externa (see Fig. 519) and sometimes the n. spermaticus externus. On the posterior surface of the posterior wall there often run a few bundles of muscle fibres, *m. interfoveolaris*, either directly behind the lig. interfoveolare, or somewhat more medianward; they arise like a fan behind the m. transversus (sometimes also from it) and extend downward to the posterior surface of the lig. inguinale and the lig. lacunare.

The ***annulus inguinalis abdominalis*** lies somewhat medianward above the middle of the lig. inguinale, is bounded medianward and below by the lig. interfoveolare and flattens out gradually lateralward and upward.



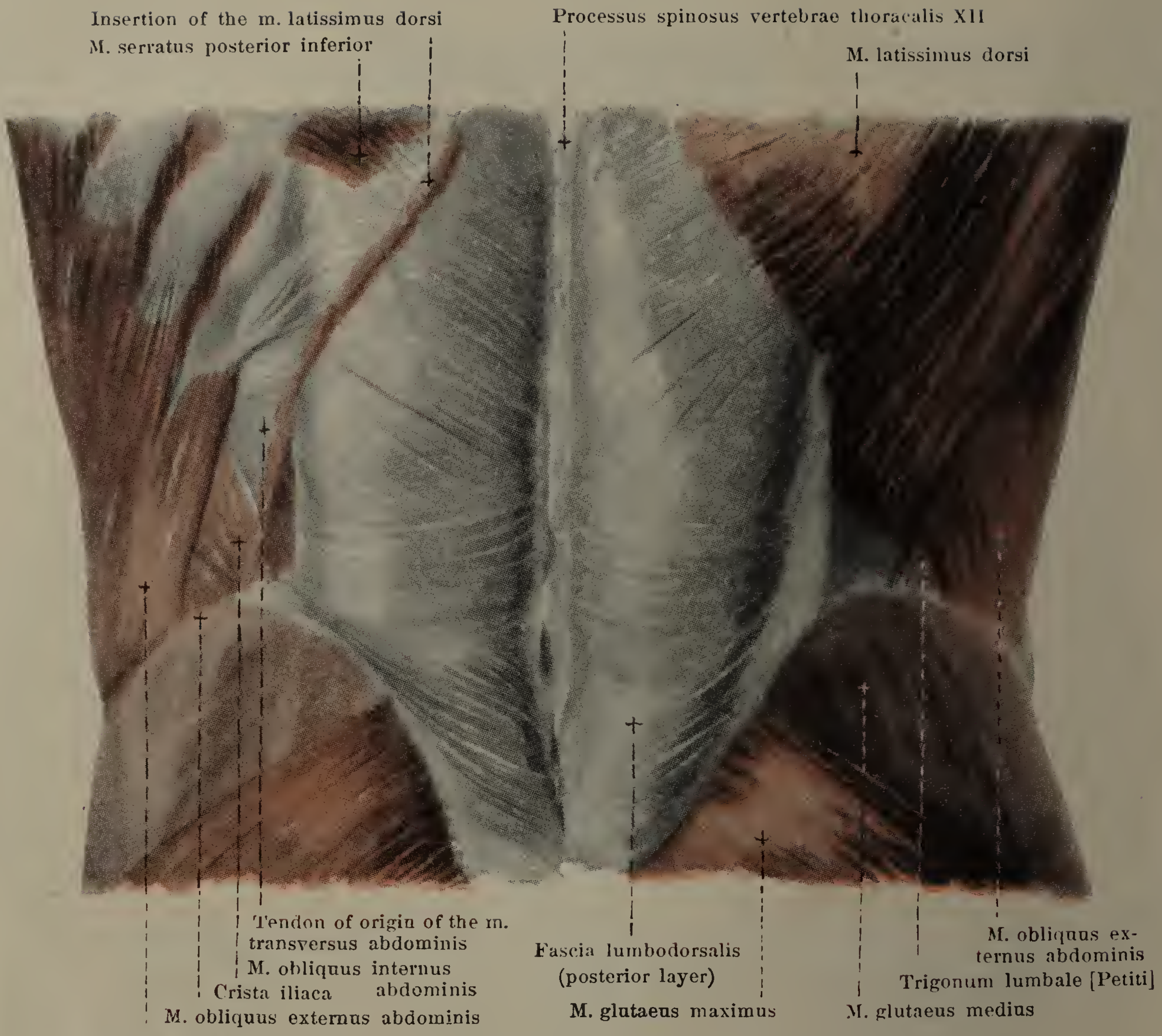
380. **Broad muscles of the back,** viewed from behind.



381. Broad muscles of the back (2nd layer), viewed from behind.

(The mm. trapezii and sternocleidomastoidei have been removed.)

M. trapezius (see Fig. 380). Form: flat, triangular, broad. Position: in the neck and upper part of the back, just beneath the skin. Origin (see also Fig. 347): tendinous from the linea nuchae superior, protuberantia occipitalis externa, lig. nuchae und lig. supraspinale as far as the 12th thoracic vertebra; the tendon fibres are connected with those of the other side, are longer in the neighborhood of the vertebra prominens, and there form, on each side, a large triangular area, on the 11th and 12th thoracic vertebra frequently a small area. Insertion: the upper fibres extend obliquely downward and forward to the acromial extremity of the clavicle; the middle fibres transversely to the acromion and to the spine of the scapula; the lower fibres obliquely upward and lateralward to become attached by a small, triangular, flat tendon to the medial part of the spine of the scapula. Action: it draws on contraction of all the bundles the shoulder-blade toward the spine and rotates it so that the angulus medialis is displaced medianward, the acromion upward and medianward, the angulus inferior slightly lateralward and forward; the upper portion alone elevates, the lower portion alone depresses the shoulder-blade and turns it somewhat, causing the lower angle to move lateralward; when the shoulder-blade is fixed, it draws the head backward and rotates it, along with the face, somewhat toward the other side. Innervation: n. accessorius and a branch of the plexus cervicalis (C_2, C_3, C_4).


Insertion of the m. latissimus dorsi
M. serratus posterior inferior
Processus spinosus vertebrae thoracalis XII
M. latissimus dorsi
Tendon of origin of the m. transversus abdominis
M. obliquus internus abdominis
Crista iliaca
M. obliquus externus abdominis
Fascia lumbodorsalis (posterior layer)
M. glutaeus maximus
M. obliquus externus abdominis
Trigonum lumbale [Petiti]
M. glutaeus medius

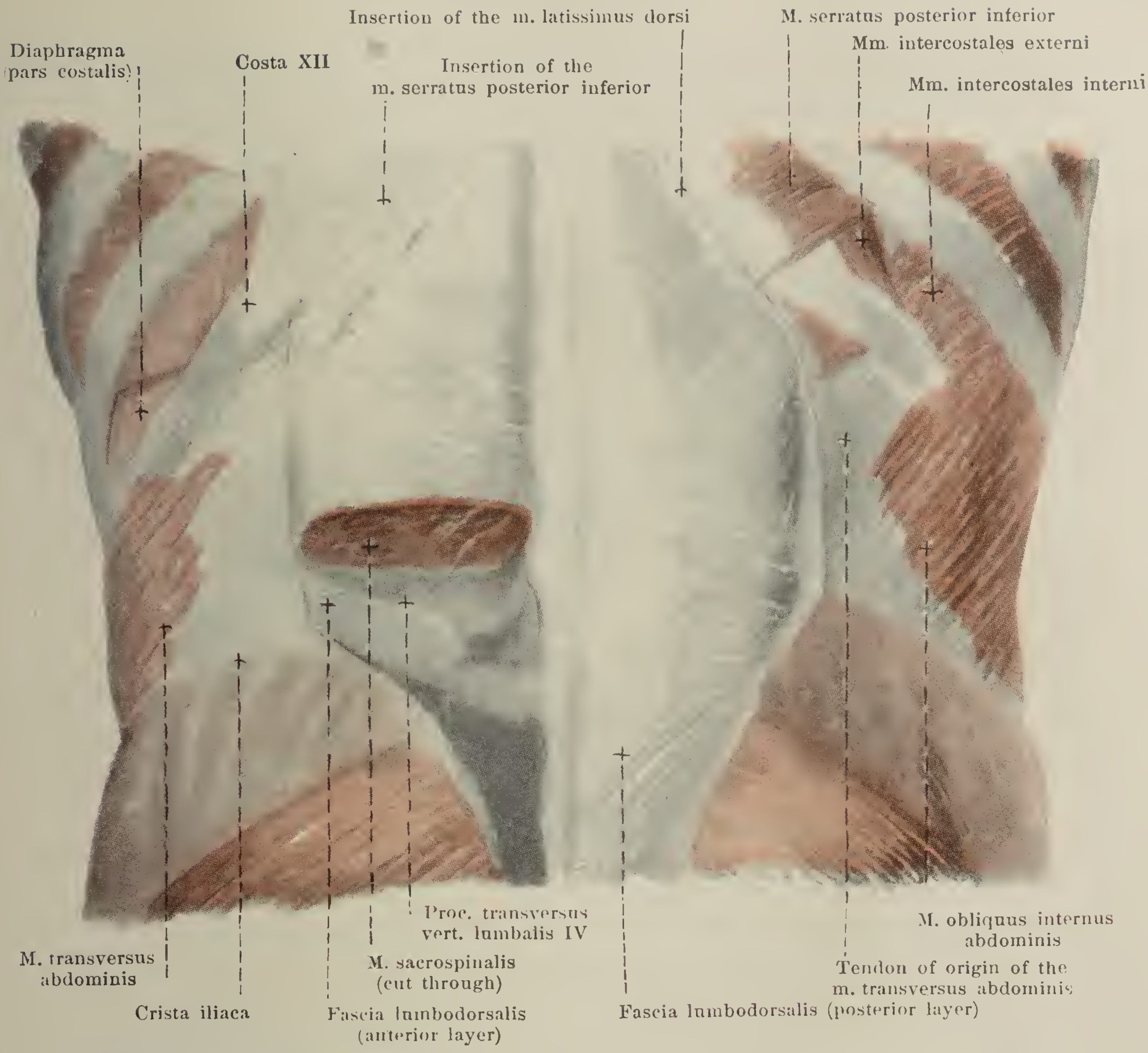
382. Muscles of the lumbar region (1st layer), viewed from behind.

(On the left side the m. latissimus dorsi has been removed.)

M. latissimus dorsi (see also Figs. 367, 380, 381 and 394). Form: flat, triangular, thin. Position: in the lower part of the back and lateral region of the thorax, being partly covered above by the m. trapezius. Origin: tendinous from the posterior layer of the fascia lumbodorsalis, from the proc. spinosus of the 7th thoracic vertebra on downward, from the crista iliaca and, by three or four fleshy digitations, from the external surface of the three or four lowermost ribs, not infrequently also from the angulus inferior. Insertion: the fibres run, converging, lateralward, the upper fibres more transversely, the lower almost straight upward; they lie on the lateral wall of the thorax close to the m. serratus anterior, cover in part the angulus inferior scapulae, join closely to the lower margin of the m. teres major, wind around it to its anterior surface and become attached by a flat tendon to the crista tuberculi minoris humori. Between the two muscles there lies the *bursa m. latissimi dorsi* (see Fig. 396). Action: it draws the arm medianward and backward and rolls it inward; it draws the vertically elevated arm downward; it draws the shoulder-blade medianward and downward. Innervation: n. thoracodorsalis ([C_6] **C_7**, C_8).

M. rhomboideus major (see Figs. 380 and 381). Form: flat, quadrangular. Position: upper part of the back, covered by the m. trapezius: under it a traingular area immediately underneath the skin. Origin: tendinous from spinous processes and interspinal ligaments of the 1st—4th thoracic vertebra. Insertion: the fibres run parallel downward and lateralward to the margo vertebralis scapulae (lower half). Action: it draws the shoulder-blade medianward and upward and rotates it at the same time so that the angulus inferior scapulae is more markedly turned medianward and upward than the acromion. Innervation: n. dorsalis scapulae (C_5).

M. rhomboideus minor (see Fig. 381), often only indistinctly separable from the preceding muscle. Form: flat, oblong-quadrangular. Position: directly on the upper margin of the preceding muscle. Origin: tendinous from the lig. nuchae and the spinous processes of the two lower cervical vertebrae. Insertion: like that of the preceding muscle, just above the same, including the trigonum spinae scapulae. Action and innervation: same as for the preceding muscle.


Diaphragma (pars costalis)
Costa XII
Insertion of the m. latissimus dorsi
Insertion of the m. serratus posterior inferior
M. serratus posterior inferior
Mm. intercostales externi
Mm. intercostales interni
Proc. transversus vert. lumbalis IV
M. obliquus internus abdominis
M. transversus abdominis
M. sacrospinalis (cut through)
Tendon of origin of the m. transversus abdominis
Crista iliaca
Fascia lumbodorsalis (anterior layer)
Fascia lumbodorsalis (posterior layer)

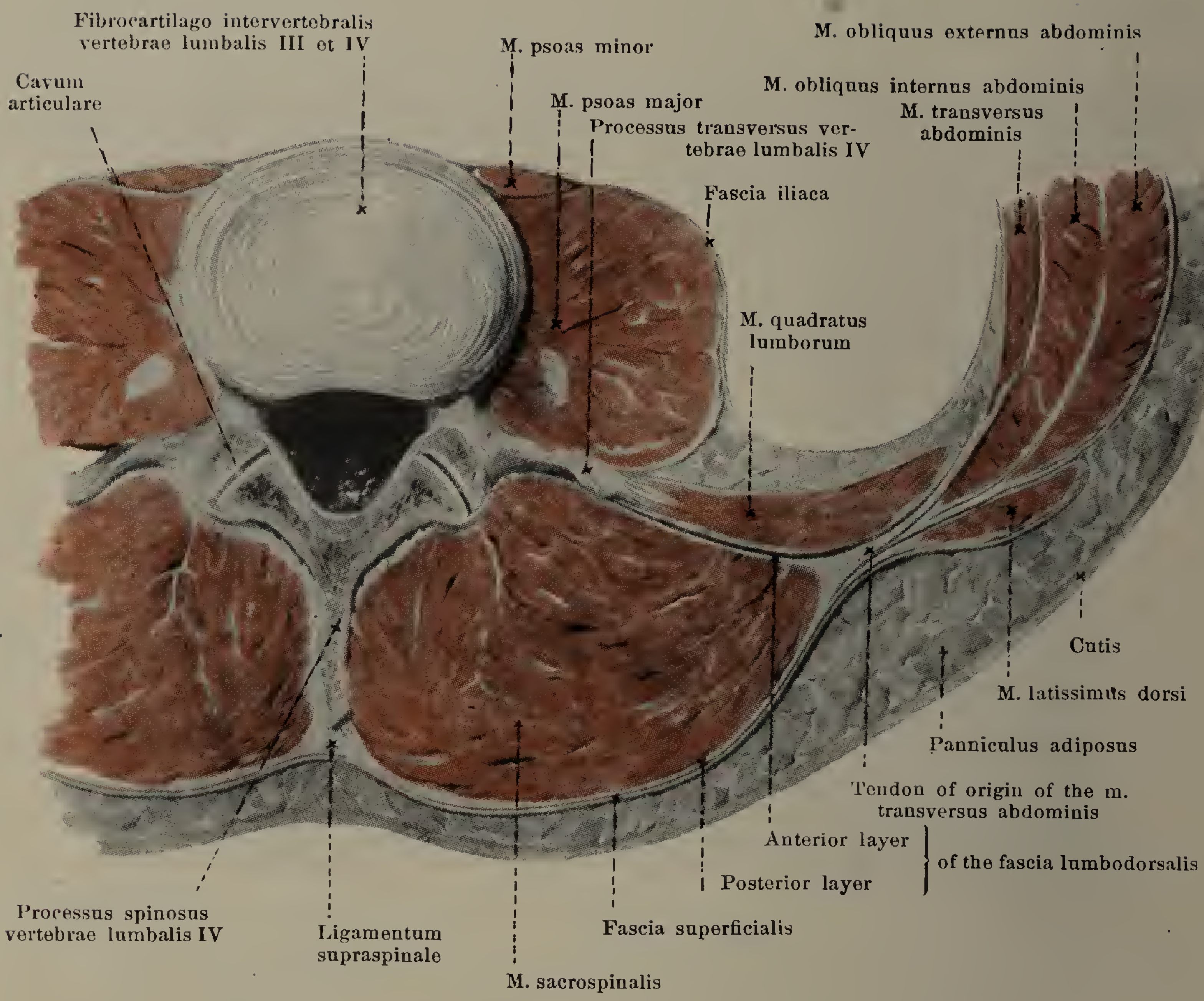
383. Muscles of the lumbar region (2nd layer), **viewed from behind.**

(The mm. latissimus dorsi and obliquus externus abdominis have been removed on both sides; on the left side the mm. obliquus internus abdominis and serratus posterior inferior have also been removed).

M. levator scapulae (O. T. levator anguli scapulae) (see Figs. 350—352 and 381). Form: flatly rounded, oblong. Position: on the lateral surface of the neck, covered above by the m. sternocleidomastoideus and below by the m. trapezius, in front coming in contact with the m. scalenus posterior, behind with the mm. splenii cervicis et capitis. Origin: by four tendinous processes becoming weaker from above downward, from the transverse processes (posterior tubercles) of the 1st—4th cervical vertebra (see Figs. 357 and 386). Insertion: the bundles run slightly twisted downward, backward and lateralward to the margo vertebralis scapulae above the trigonum spinae scapulae. Action: it draws the shoulder-blade medianward and upward and rotates it so that the angulus inferior is turned strongly medianward and upward, and the acromion less markedly upward; when the shoulder-blade is fixed, it bends the cervical portion of the spine and rotates it somewhat to the same side. Innervation: n. dorsalis scapulae ([C_2] C_3, C_4, C_5).

Trigonum lumbale [Petiti] (O. T. Petit's triangle) (see Fig. 382), a triangular thinner spot of the posterior abdominal wall, varying in size; below it is bounded by the crista iliaca, lateralward by the posterior margin of the m. obliquus externus abdominis, medianward by the lateral margin of the m. latissimus dorsi. In this triangle the muscle fibres of the m. obliquus internus are visible; in front of them lies the tendon of origin of the m. transversus abdominis and of the m. quadratus lumborum.

Fascia nuchae (not represented in the figure) is a thin membrane of connective tissue which lies just beneath the mm. trapezius and rhomboidei; it goes off from the inferior surface of the squama occipitalis, covers the mm. splenii capitis et cervicis and semispinalis capitis, i. e. the muscles depicted in Fig 392, is connected medianward with the lig. nuchae, is continued in front into the fascia colli and goes over below at the m. serratus posterior superior into the fascia lumbodorsalis.


Fibrocartilago intervertebralis vertebrae lumbalis III et IV
Cavum articulare
M. psoas minor
M. psoas major
Processus transversus vertebrae lumbalis IV
M. obliquus externus abdominis
M. obliquus internus abdominis
M. transversus abdominis
Fascia iliaca
M. quadratus lumborum
Cutis
M. latissimus dorsi
Panniculus adiposus
Tendon of origin of the m. transversus abdominis
Anterior layer
Posterior layer
of the fascia lumbodorsalis
Processus spinosus vertebrae lumbalis IV
Ligamentum supraspinale
Fascia superficialis
M. sacrospinalis

384. Transverse section through the muscles of the lumbar region (after W. Braune).

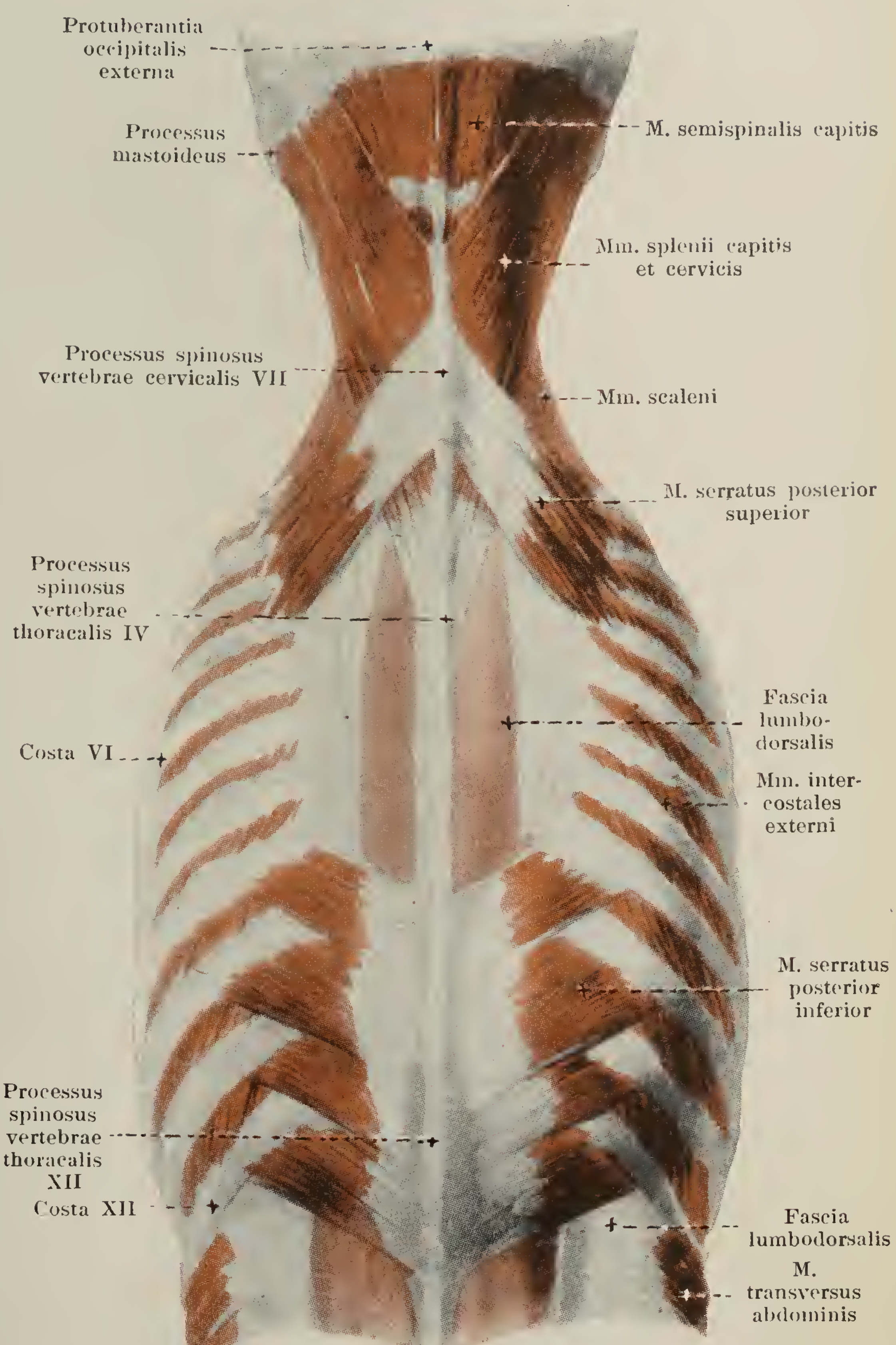
The **fascia lumbodorsalis** consists of two layers, the posterior and the anterior layer.

The posterior layer (see also Figs. 380, 382, 383 and 385) lies just below the mm. trapezius, rhomboidei and latissimus dorsi on the posterior surface of the m. sacrospinalis, is thin at its beginning at the m. serratus posterior superior, where it is continuous with the fascia nuchae (see p. 305), forms a sheath below for the m. serratus posterior inferior and, becoming stronger, descends as far as the coccygeal region; on its way it is fused medianward with the spinous processes and supraspinal ligament of the thoracic and lumbar vertebrae and with the crista sacralis media; below, it fuses with the tendons of origin of the m. sacrospinalis, with the posterior ligaments of the sacrum and with the crista iliaca, lateralward with the anguli costarum and, below the ribs, between them and the crista iliaca, with the anterior layer. It consists above of transverse, below of oblique crossing fibres, which represent in part the immediate continuation of the mm. serratus posterior inferior and latissimus dorsi arising from the fascia.

The anterior layer (see also Figs. 363, 366, 383 and 391) is thinner, lies in front of the m. sacrospinalis, behind the mm. quadratus lumborum and psoas major and extends only from the 12th rib to the crista iliaca, being fastened to both. It arises by four processes from the transverse processes of the 1st—4th lumbar vertebra, is connected below with the lig. iliolumbale and coitains, above, powerful, curved fibrous bands which extend from the 1st and 2nd lumbar vertebra to the 12th rib, the *ligamentum lumbocostale* (see Figs. 363, 366 and 391). The fibres of the anterior layer run essentially transversely, unite lateral from the m. sacrospinalis with the fibres of the posterior layer and thus together form the tendon of origin of the m. transversus abdominis; the m. obliquus internus abdominis arises in part from the posterior surface of the combined layers.

385. Broad muscles of the back (3rd layer), viewed from behind.

(The shoulder-blades and the muscles going to them have been removed.)

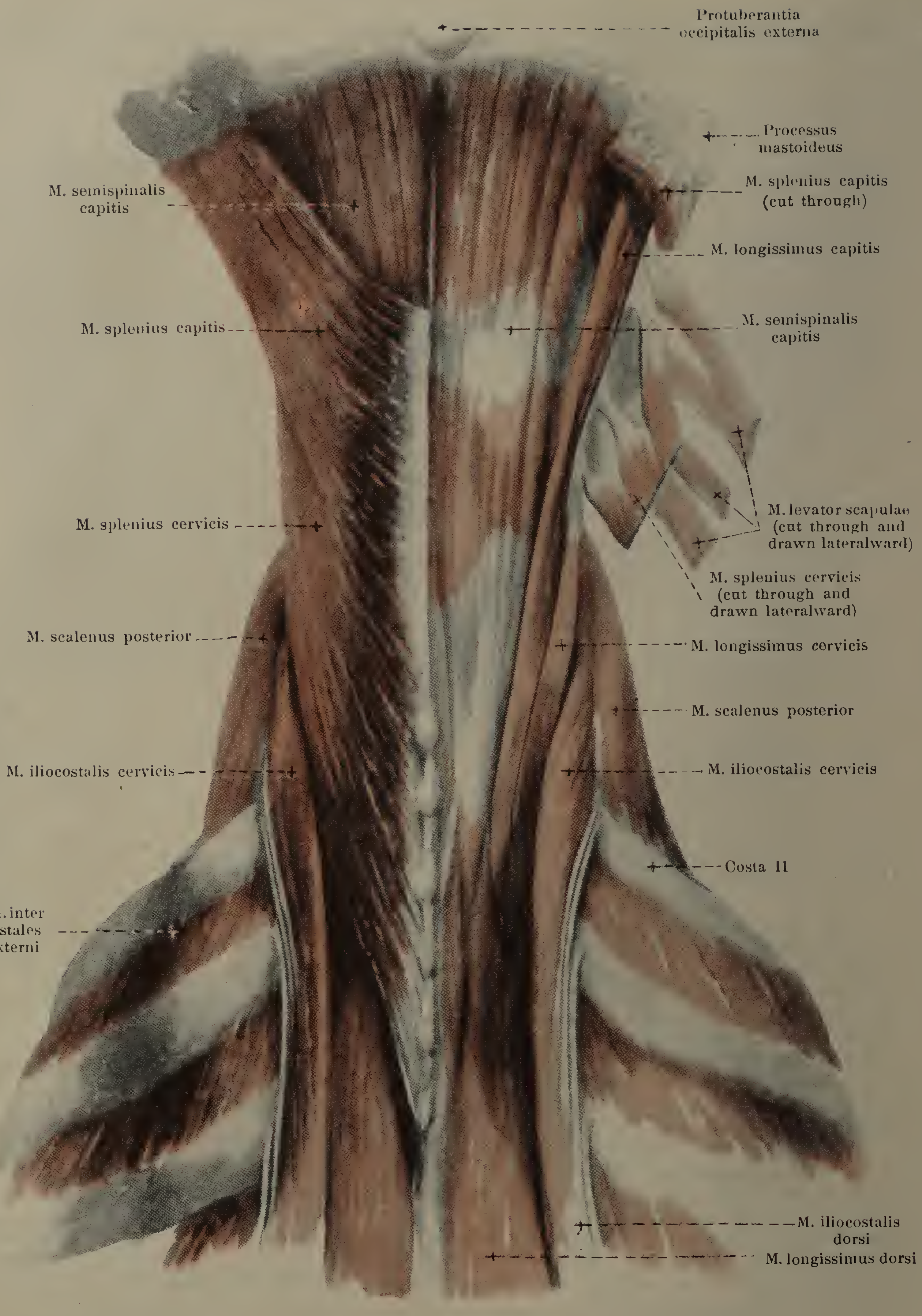

Protuberantia occipitalis externa
Processus mastoideus
M. semispinalis capitis
Mm. splenii capitis et cervicis
Processus spinosus vertebrae cervicalis VII
Mm. scaleni
M. serratus posterior superior
Processus spinosus vertebrae thoracalis IV
Fascia lumbodorsalis
Costa VI
Mm. intercostales externi
M. serratus posterior inferior
Processus spinosus vertebrae thoracalis XII
Costa XII
Fascia lumbodorsalis
M. transversus abdominis

M. serratus posterior superior (O. T. serratus posticus superior). Form: flat, quadrangular, very thin. Position: upper part of the back, covered by the mm. rhomboidei. Origin: by a flat tendon from the lig. nuchae or the spinous processes of the 6th and 7th cervical, as well as from the 1st and 2nd thoracic vertebra. Insertion: the fibres run parallel, obliquely lateralward and downward and terminate by four fleshy digitations on the 2nd to 5th rib. Action: it elevates these ribs. Innervation: nn. intercostales I—IV, often also a branch of the plexus brachialis (C_8).

M. serratus posterior inferior (O. T. serratus posticus inferior) (see also Fig. 382). Form: flat, quadrangular, very thin. Position: lower part of the back, covered by the m. latissimus dorsi and partly also by the m. trapezius. Origin: posterior layer of the fascia lumbodorsalis in the region of the 10th to 12th thoracic and the 1st and 2nd lumbar vertebra. Insertion: the fibres run parallel obliquely lateralward and upward and terminate by four fleshy digitations on the 9th—12th rib. Action: it draws these ribs downward and outward; it contracts on inspiration. Innervation: nn. intercostales IX—XII.

M. splenius capitis (see also Figs. 347, 352, 381 and 386). Form: flat, oblong-quadrangular, thick. Position: in the neck, partly covered by the mm. trapezius, sternocleidomastoideus, serratus posterior superior and rhomboidei. It embraces on both sides the mm. semispinalis capitis, longissimus capitis et cervicis. Origin: lig. nuchae at the level of the 3rd—7th cervical vertebra as well as from the spinous processes of the 1st and 2nd thoracic vertebra. Insertion: the fibres converge somewhat and pass upward and lateralward by a thick, short tendon to the proc. mastoideus and to the linea nuchae superior oss. occipitalis. Action: it rotates the head so that the face is turned upward and toward the same side; the muscles of the two sides together bend the head backward. Innervation: rami laterales of the rami posteriores of the nn. cervicales I—IV (V).

M. splenius cervicis (O. T. splenius colli) (see Figs. 347, 381 and 386). Form: flat, oblong-quadrangular, narrow. Position: it forms in a way a continuation downward of the preceding muscle and is often indistinctly separable from it. Origin: procc. spinosi and ligg. interspinalia of the 3rd—6th thoracic vertebra. Insertion: by 2—3 processes to the tubercula posteriora of the procc. transversi of the 2—3 uppermost cervical vertebrae. Action: it bends the neck backward and lateralward and rotates the 2—3 upper cervical vertebrae like the preceding muscle rotates the head. Innervation: like that of the preceding muscle.

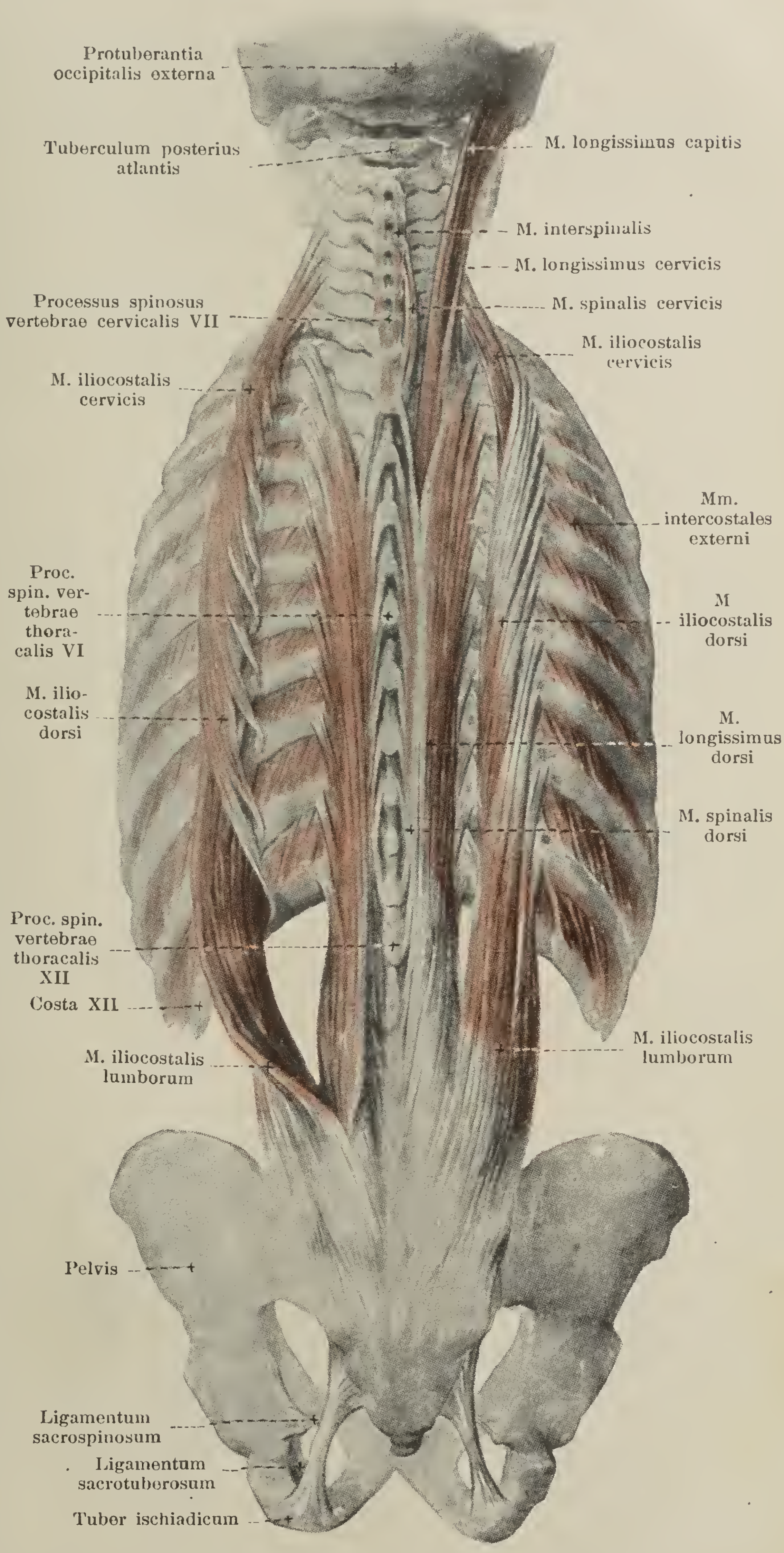


386. Muscles of the neck (left: 2nd layer, right: 3rd layer), viewed from behind.

(On both sides the mm. trapezius, sternocleidomastoideus and levator scapulae have been removed, on the right side the mm. splenii have also been removed.)

387. Long muscles of the back (1st layer), viewed from behind

(On the right side the m. iliocostalis has been pulled lateralward, on the left side it has been reflected.)



M. sacrospinalis (O. T. erector spinae) (see also Figs. 383, 384 and 388—391). Form: triangular-prismatic, long. Position: lateralward from the m. transversospinalis, from the sacral region to the neck. Origin: fleshy in the depth, otherwise by long tendons from the crista iliaca, ligg. sacroiliaca posteriora, crista sacralis media and spinous processes of the lumbar vertebrae and of the 2 (or 3) lowermost thoracic vertebrae. The mass of fibres is divisible in the lumbar region into three separate muscles: m. iliocostalis, m. longissimus and m. spinalis.

M. iliocostalis (O. T. external division of erector spinae), farthest lateralward, extends between the ribs or their homologues.

M. iliocostalis lumborum (O. T. sacrolumbalis). Insertion: by nine processes, the lower ones fleshy, the upper ones thin and tendinous, to the angles of the 12th—4th rib. Action: it can depress the ribs.

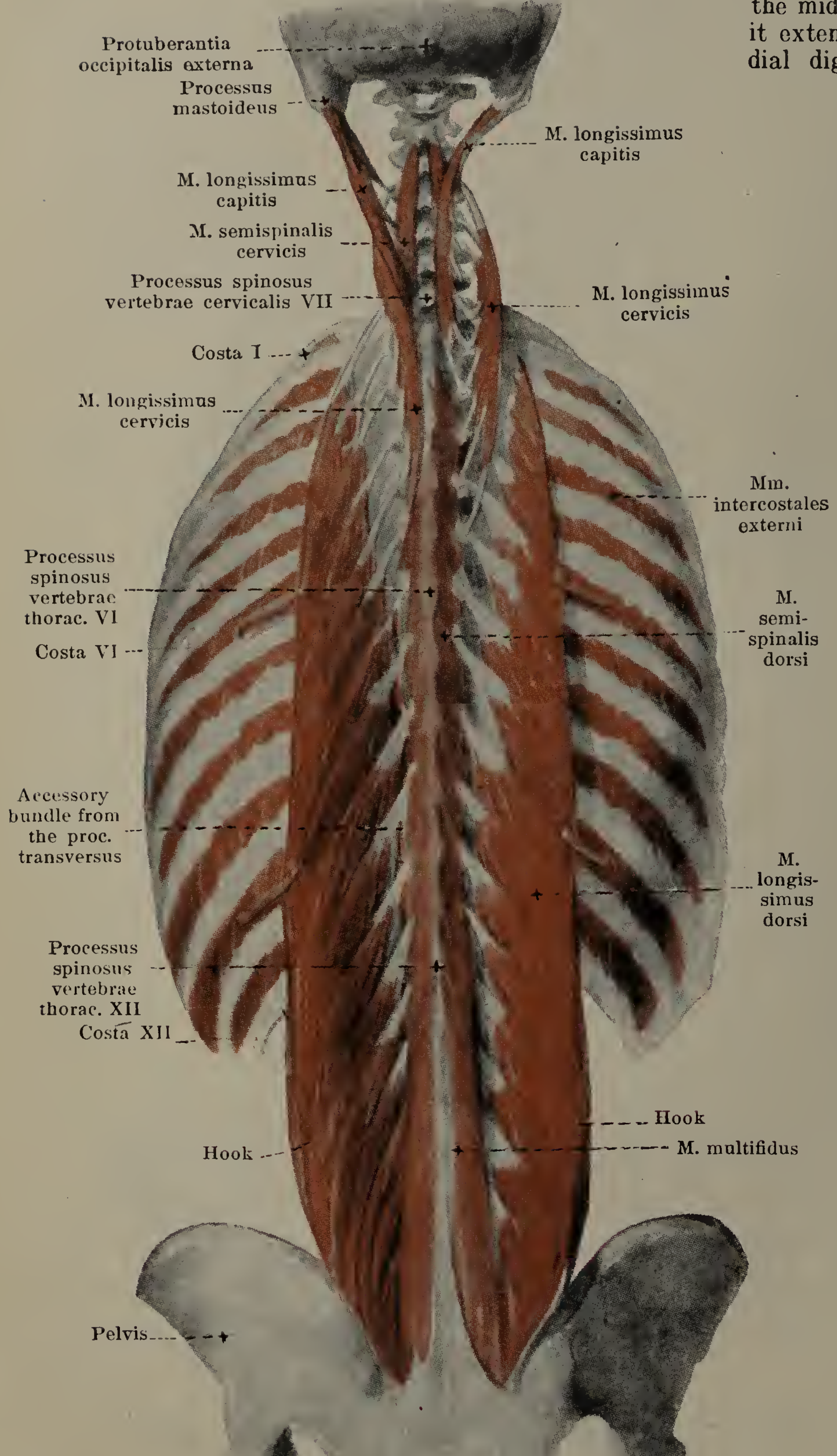
M. iliocostalis dorsi (O. T. accessory to the iliocostal). Origin: covered by the preceding, it arises by six fleshy digitations from the angles of the 12th—7th rib. Insertion: by eight thin tendons to the angles of the 7th to 1st rib and the transverse process of the 7th cervical vertebra.

M. iliocostalis cervicis (O. T. cervicalis ascendens) (see also Fig. 386). Position: it is bounded in front by the m. scalenus posterior, lateralward and behind by the m. levator scapulae, medianward by the mm. splenius and longissimus cervicis. Origin: covered by the preceding muscle, it arises by 4—6 fleshy processes from the angles of the 6th—3rd (2nd or 1st) rib. Insertion: by three narrow tendons to the transverse processes of the 6th—4th cervical vertebra. Action: it bends the neck backward and toward the same side; it can elevate the ribs.

Action of the whole m. iliocostalis: it bends the spinal column backward and toward the same side. Innervation: rami laterales of the rami posteriores of the nn. thoracales I to XII and lumbalis I.

388. Long muscles of the back (2nd layer), viewed from behind.

(The mm. iliocostales have been removed; the mm. longissimi dorsi have been reflected outward; the m. longissimus cervicis has been, on the right side, drawn lateralward, on the left side, medianward; the m. longissimus capitis has been drawn medianward on the right side.)



M. longissimus (O. T. middle division of erector spinae) (see also Fig. 387) is the middle bundle of the m. sacrospinalis; it extends (in the thorax only by its medial digitations) between the transverse processes or their homologues.

M. longissimus dorsi. Origin: it receives very frequently medianward several short, accessory bundles from the procc. mamillares of the 1st and 2nd lumbar vertebrae and the transverse processes of the lower 6—7 thoracic vertebre. Insertion: 1st, by thin, lateral processes, fleshy below, tendinous above (often partly absent), to the transverse processes of the 5th to 1st lumbar vertebra and the angles of the 12th—2nd rib (see Fig. 387); 2nd, by medial processes, below fleshy, above tendinous (always present), to the procc. accessorii of the 5th to 1st lumbar vertebra and the procc. transversi of all the thoracic vertebrae. Action: it bends the spinal column backward and toward the same side.

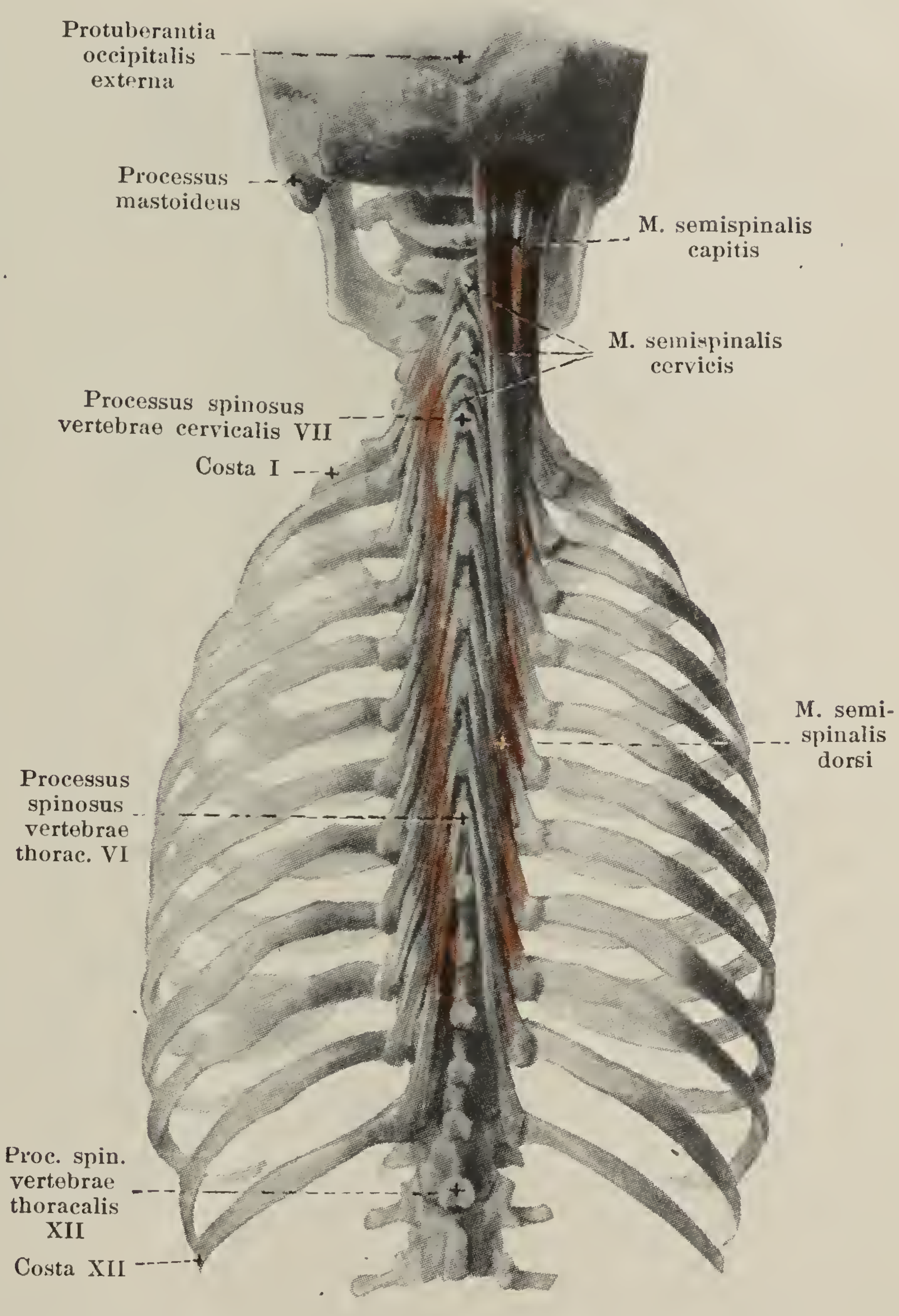
M. longissimus cervicis (see also Fig. 386). Form: flat, thin. Position: medianward from the m. iliocostalis cervicis, lateralward from the m. longissimus capitis covered by mm. splenius cervicis and trapezius. Origin: uppermost 4—6 thoracic vertebrae. Insertion: the middle cervical vertebrae. Action: it bends the neck backward and toward the same side.

M. longissimus capitis (O. T. trachleomastoid) (see also Fig. 386). Form: flat, oblong-quadrangular, thin; usually fused with the preceding muscle. Position: medianward from the m. longissimus cervicis, lateralward from the m. semispinalis capitis covered by mm. splenii and trapezius. Origin: procc. transversi of the 3rd—1st thoracic vertebra and procc. articulares of the 7th—3rd cervical vertebra. Insertion: thickened and tendinous to the proc. mastoideus. Action: it draws the head backward, bends and turns it toward the same side.

Innervation: rami laterales of the rami posteriores of the nn. cervicales I—VIII, thoracales I—XII, lumbales I—V.

389. Short muscles of the back (1st layer), viewed from behind.

(The m. semispinalis capitis has been removed on the left side.)


Protuberantia occipitalis externa
Processus mastoideus
M. semispinalis capitis
M. semispinalis cervicis
Processus spinosus vertebrae cervicalis VII
Costa I
M. semispinalis dorsi
Processus spinosus vertebrae thorac. VI
Proc. spin. vertebrae thoracalis XII
Costa XII

M. spinalis (O. T. inner division of erector spinae) (see Fig. 387), very thin, forms the medial part of the m. sacrospinalis and extends between spinous processes.

M. spinalis dorsi. Origin: fleshy from the bundles of the m. longissimus, which arise from the two uppermost lumbar and the two (or three) lowermost thoracic vertebrae. Insertion: grown together with mm. semispinalis and multifidus, from the 9th (or 8th) to the 2nd thoracic vertebra inclusive; one vertebra (10th or 9th) is passed over without attachment.

M. spinalis cervicis (O. T. spinalis colli), very variable. Origin: two uppermost thoracic and two lowermost cervical vertebrae. Insertion: 4th to 2nd cervical vertebra. Action: they extend the spinal column. Innervation: rami mediales of the rami posteriores of the nn. cervicales III—VIII and thoracales II, VI, VII, VIII.

M. spinalis capitis see under m. semispinalis capitis.

M. transversospinalis is the name applied to the mass of fibres running obliquely upward from the procc. transversi to the procc. spinosi and which like a three-sided prismatic cord fills the groove between the procc. spinosi and transversi. On the surface its fibres run more vertically than deep down. It is subdivided into m. semispinalis, m. multifidus and mm. rotatores.

M. semispinalis (see also Fig. 388) is the superficial layer of the m. transversospinalis; its fibres pass over more than four vertebral bodies before becoming attached. The muscle is absent in the lumbar region.

M. semispinalis dorsi. Origin: procc. transversi of the six lower thoracic vertebrae. Insertion: procc. spinosi of the six upper thoracic and two lower cervical vertebrae.

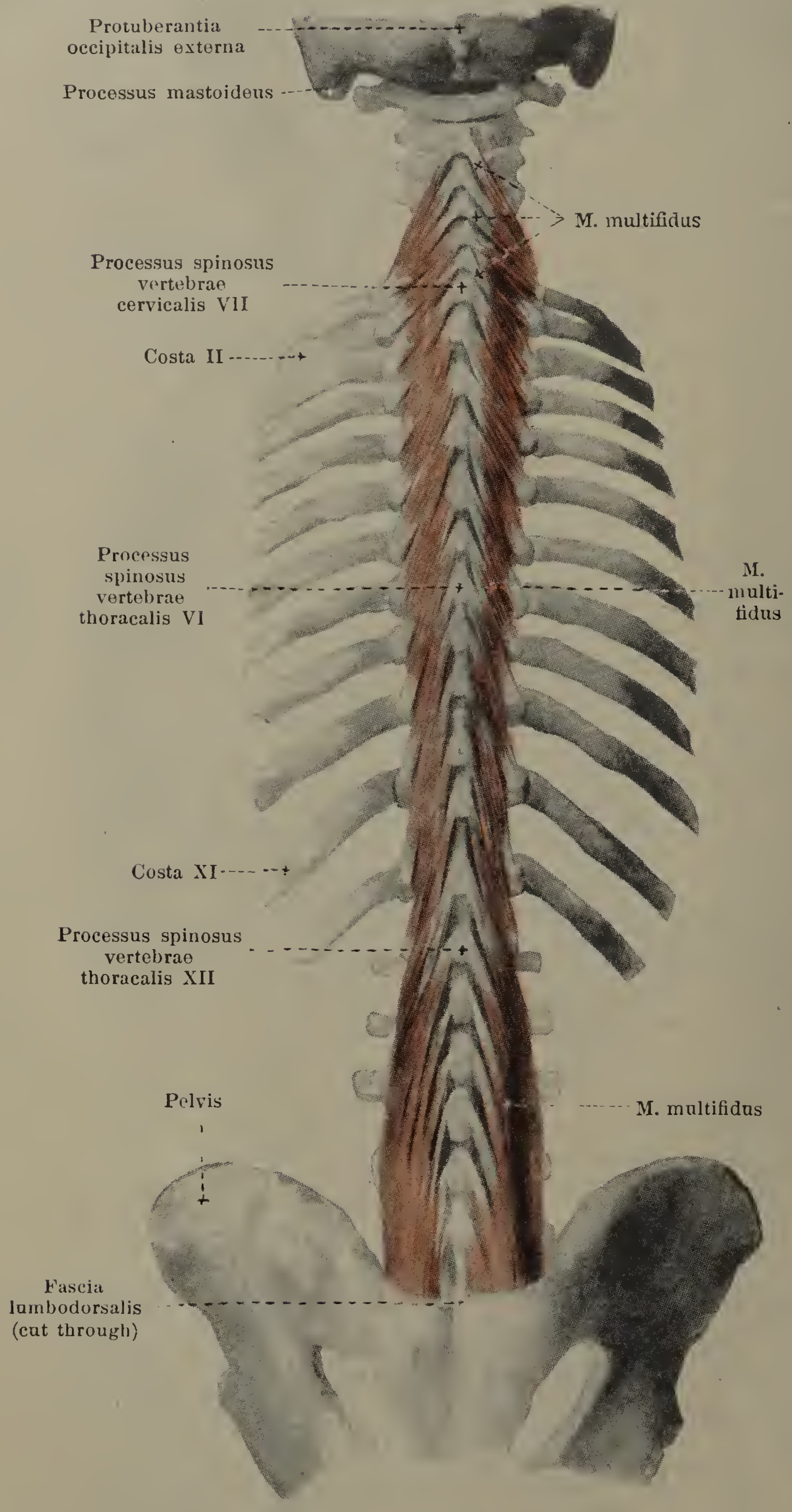
M. semispinalis cervicis (O. T. semispinalis colli). Origin: procc. transversi of the six upper thoracic vertebrae. Insertion: procc. spinosi of the 5th—2nd cervical vertebra.

Action: they bend the spinal column backward and toward the same side, and rotate it toward the opposite side.

Innervation: rami mediales of the rami posteriores of the nn. cervicales III—VI (VII) and thoracales (III) IV—VI, XI, XII.

M. semispinalis capitis (O. T. complexus) (see also Figs. 347 and 386). Form: flat, oblong-quadrangular, thick. Position: bounded medianward by the lig. nuchae, in front by mm. semispinalis cervicis, recti capitis posteriores and obliqui capitis, lateralward by the m. longissimus capitis, covered in large part by the mm. splenii and trapezius. Origin: procc. transversi of the six upper thoracic vertebrae, procc. transversi et articulares of the 3—4 lower cervical vertebrae and (sometimes absent) procc. spinosi of the uppermost thoracic and lowermost cervical vertebrae. The fibres coming from the procc. spinosi are sometimes separated so as to form an independent muscle, the *m. spinalis capitis. Insertion:* the fibres run parallel upward and somewhat medianward to the under surface of the squama occipitalis; they are interrupted, especially medianward by one or several jagged intermediate tendons. Action: it draws the head backward and raises the face toward the other side. Innervation: rami mediales et laterales of the rami posteriores of the nn. cervicales I—IV.

390. Short muscles of the back (2nd layer), viewed from behind.


Protuberantia occipitalis externa
Processus mastoideus
M. multifidus
Processus spinosus vertebrae cervicalis VII
Costa II
Processus spinosus vertebrae thoracalis VI
M. multifidus
Costa XI
Processus spinosus vertebrae thoracalis XII
Pelvis
M. multifidus
Fascia lumbodorsalis (cut through)

M. multifidus (see also Fig. 388) is the second layer of the muscular mass extending from the procc. transversi to the procc. spinosi obliquely upward; it lies in the thorax and neck just below the m. semispinalis, in the lumbar region just below the m. longissimus dorsi; its fibres bridge over from two to four vertebral bodies. Origins: tuberositas iliaca, ligg. sacroiliaca posteriora, posterior surface of the sacrum, procc. mamillares of the lumbar vertebrae, procc. transversi of the thoracic vertebrae and procc. articulares of the 7th—5th cervical vertebra. Insertions: procc. spinosi of the lumbar, thoracic and cervical vertebrae (with the exception of the atlas). Action: it bends the whole spinal column backward and a trifle toward the same side and rotates the cervical portion and the thoracic portion of the spine toward the opposite side (but not the lumbar portion of the spine). Innervation: rami mediales of the rami posteriores of the nn. cervicales III to VIII, thoracales I—XII and lumbales I—V.

The **mm. rotatores** (see Fig. 391) form the third, deepest layer of the fibre masses going obliquely upward from the procc. transversi to the procc. spinosi; they are completely hidden by the m. multifidus. They consist of single, narrow, thin muscle bands.

Mm. rotatores longi bridge over one vertebra.

Mm. rotatores breves go to the next vertebra above.

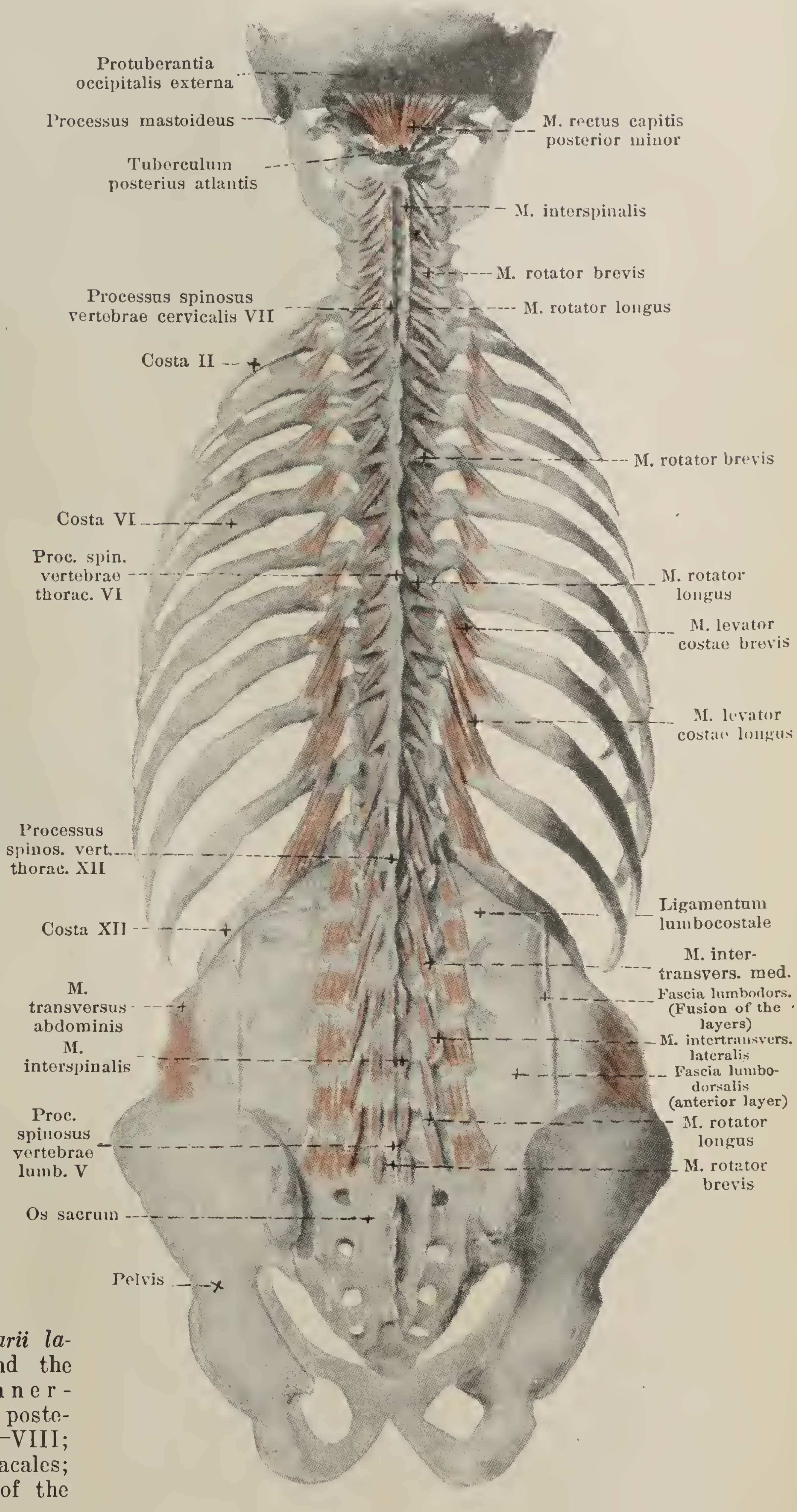
Both go on the lumbar vertebrae from the proc. mamillaris, on the thoracic vertebrae from the root of the proc. transversus and on the cervical vertebrae from the proc. articularis inferior to the root of the proc. spinosus or to the arcus vertebrae, are present from the sacrum as far as the 2nd cervical vertebra and, below, run nearly vertically, above, more transversely. Action and Innervation: same as for the m. multifidus.

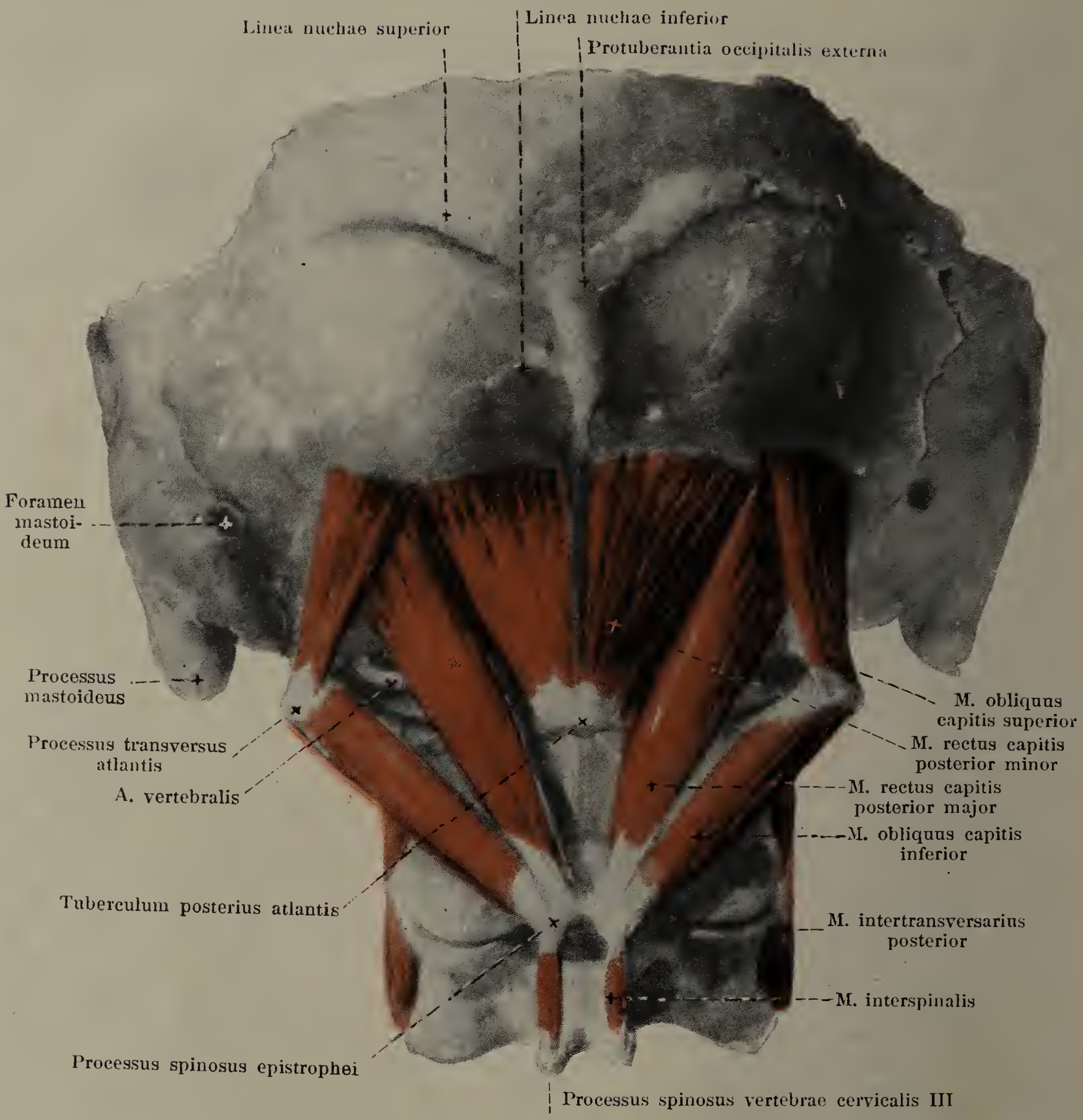
391. Short muscles of the back (3rd layer), viewed from behind.

Mm. levatores costarum. Form: flat, triangular, thin. Position: behind the articulationes costotransversariae, covered by the m. longissimus. Origin: procc. transversi of the 7th cervical and 1st—11th thoracic vertebra. Insertion: lateralward and downward to the next rib below *(mm. levatores costarum breves)*; in the 3—4 lower intercostal spaces also to the next rib but one below *(mm. levatores costarum longi)*. They are directly adjacent to the mm. intercostales externi. Action: elevate the ribs. Innervation: ramus anterior of the n. cervicalis VIII and nn. intercostales I—XI.

Mm. interspinales, short bundles between every two neighboring spinous processes; from the epistropheus to the sacrum. They are often double on the cervical vertebrae, are usually absent from the thoracic vertebrae but very powerful on the lumbar vertebrae. Action: they bend the spinal column backward. Innervation: rami mediales of the rami posteriores of the nn. cervicales III—VIII, thoracales I—XII and lumbales I—V.

Mm. intertransversarii (O. T. intertransversales), short bundles between every two neighboring transverse processes. They are usually absent from the thoracic vertebrae. They are double on the cervical vertebrae, extending between adjacent tubercula anteriora *(mm. intertransversarii anteriores)* and also between adjacent tubercula posteriora *(mm. intertransversarii posteriores)*. (See Fig. 392.) They are double also on the lumbar vertebrae extending between the procc. mamillares et accessorii *(mm. intertransversarii mediales)* and between the procc. transversi *(mm. intertransversarii laterales)*. Action: they bend the spinal column to the side. Innervation: rami anteriores et posteriores of the nn. cervicales II—VIII; rami posteriores of the nn. thoracales; rami anteriores et posteriores of the nn. lumbales I—V.


Protuberantia occipitalis externa
Processus mastoideus
M. rectus capitis posterior minor
Tuberculum posterius atlantis
M. interspinalis
M. rotator brevis
Processus spinosus vertebrae cervicalis VII
M. rotator longus
Costa II
M. rotator brevis
Costa VI
Proc. spin. vertebrae thorac. VI
M. rotator longus
M. levator costae brevis
M. levator costae longus
Processus spinos. vert. thorac. XII
Ligamentum lumbocostale
Costa XII
M. inter-transvers. med.
M. transversus abdominis
Fascia lumbodors. (Fusion of the layers)
M. interspinalis
M. intertransvers. lateralis
Fascia lumbodorsalis (anterior layer)
Proc. spinosus vertebrae lumb. V
M. rotator longus
M. rotator brevis
Os sacrum
Pelvis


Linea nuchae superior
Linea nuchae inferior
Protuberantia occipitalis externa
Foramen mastoideum
Processus mastoideus
Processus transversus atlantis
A. vertebralis
Tuberculum posterius atlantis
Processus spinosus epistrophei
Processus spinosus vertebrae cervicalis III
M. obliquus capitis superior
M. rectus capitis posterior minor
M. rectus capitis posterior major
M. obliquus capitis inferior
M. intertransversarius posterior
M. interspinalis

392. Short muscles of the neck, viewed from behind and below.

M. rectus capitis posterior major (O. T. rectus capitis posticus major). Form: flat, oblong-triangular. Position: immediately upon the vertebrae. Origin: proc. spinosus epistrophei. Insertion: slightly diverging, upward and lateralward to the planum nuchale of the squama occipitalis. Action: it draws the head backward, and rotates it (with the atlas) toward the same side. Innervation: n. suboccipitalis (C_1), possibly also ramus posterior n. cervicalis II.

M. rectus capitis posterior minor (O. T. rectus capitis posticus minor) (see also Fig. 391). Form: flat, triangular. Position: immediatly upon the membrana atlanto-occipitalis posterior, reaching as far as the median plane; lateralward it is partially covered by the preceding muscle. Origin: tuberculum posterius atlantis. Insertion: slightly diverging, upward to the planum nuchale of the squama occipitalis. Action: it draws the head backward. Innervation: n. suboccipitalis (C_1).

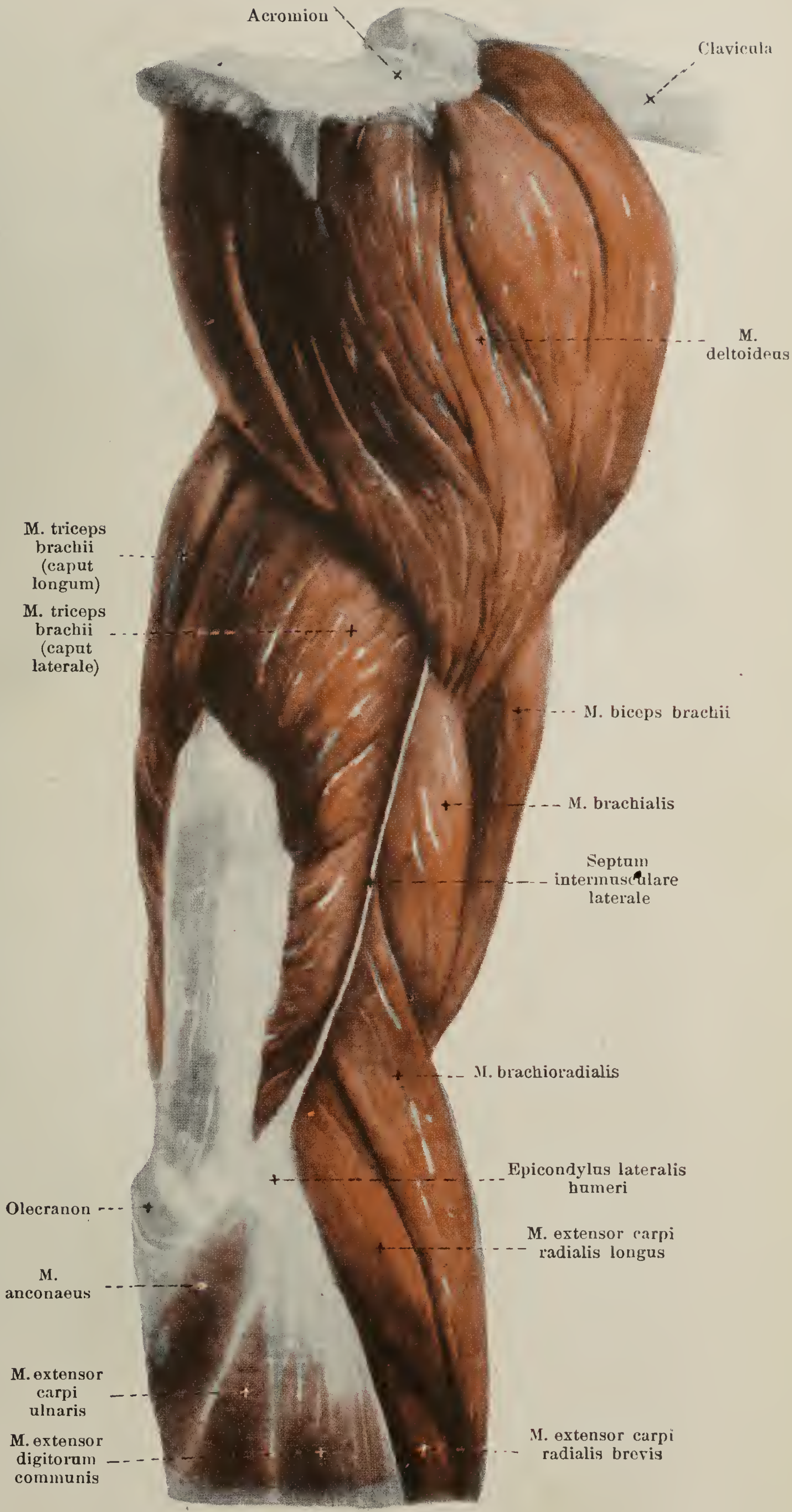
M. obliquus capitis superior. Form: flat, oblong-triangular. Position: lateralward and backward from the articulatio atlantooccipitalis. Origin: proc. transversus atlantis. Insertion: slightly diverging, obliquely upward and medianward to the planum nuchale of the squama occipitalis and attaches there behind the m. rectus capitis posterior major. Action: it draws the head backward and bends it slightly to the same side. Innervation: n. suboccipitalis (C_1).

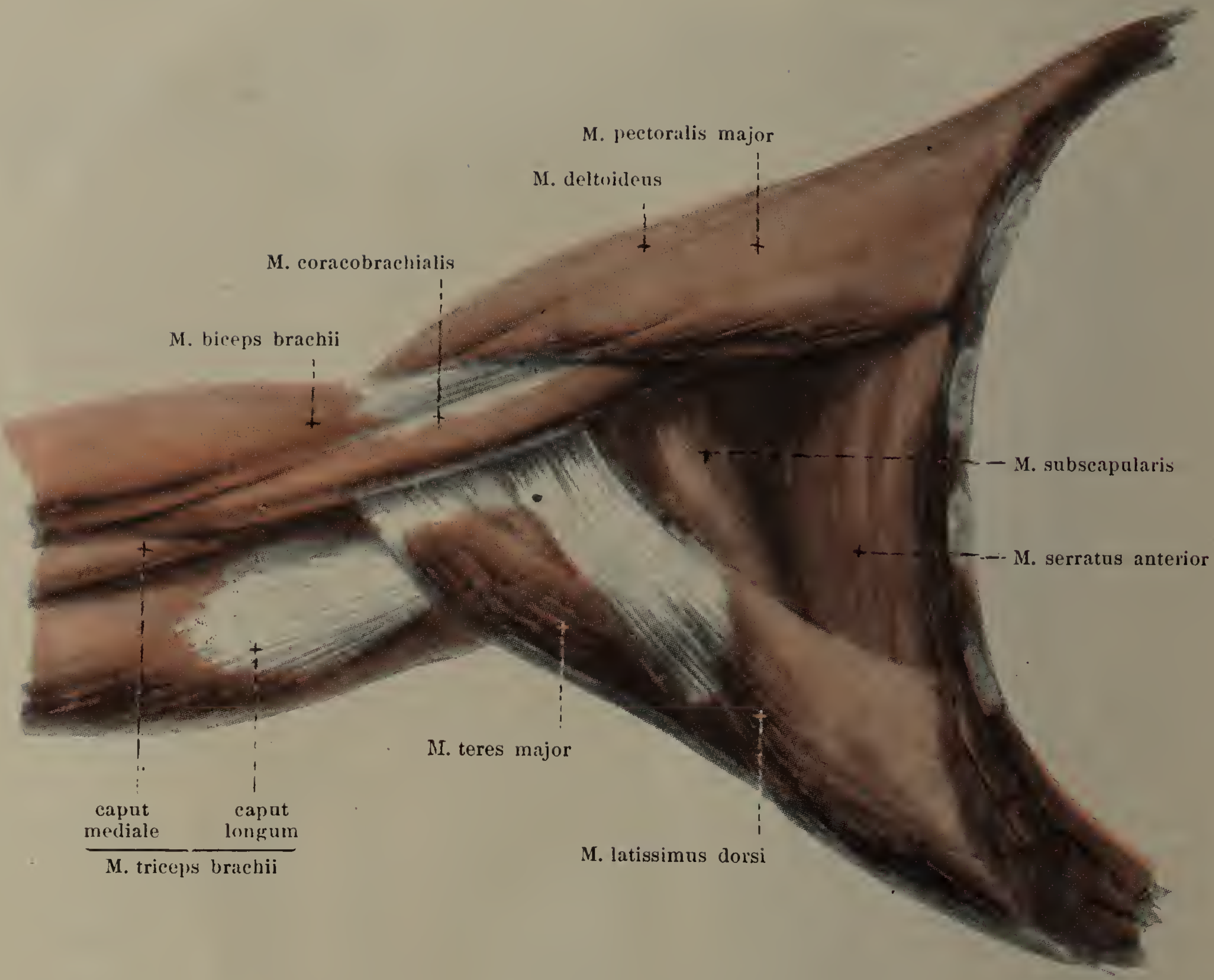
M. obliquus capitis inferior. Form: flat, oblong. Position: immediately upon the vertebrae. Origin: proc. spinosus epistrophei. Insertion: lateralward and upward to the proc. transversus atlantis. Action: it rotates the atlas (with the head) toward the same side. Innervation: n. suboccipitalis and ramus posterior n. cervicalis II (total C_1, C_2).

393. Muscles of the right upper arm, viewed from the lateral side.

M. deltoideus (see also Figs. 359, 361, 380, 381, 394, 398 and 400). Form: flat, triangular, bent so as to be markedly through-like, thicker in the middle than at the borders. Position: just beneath the skin; it forms the fleshy projection of the shoulder. Origin: fleshy from the extremitas acromialis claviculae and the acromion, tendinous from the spina scapulae connected with the fascia infraspinata. Insertion: the fibres of the anterior and posterior part run in themselves converging in almost a straight line downward and lateralward, the middle fibres curve downward over the tuberculum majus humeri *(bursa subdeltoidea,* see Fig. 318); the middle part of the muscle presents a markedly multipinnate appearance; all the fibres converge to the tuberositas deltoidea humeri, lateralward and below the insertion of the m. pectoralis major; they fasten partly to a tendinous plate covering the inner surface. Action: the middle portion lifts the upper arm lateralward in the shoulder joint; the anterior portion draws the arm forward and rolls it inward, the posterior portion draws the arm backward and rolls it outward; these both portions acting together draw the arm hanging in the vertical plane medianward, but the more abducted arm lateralward. Innervation: n. axillaris (**C5**, **C6**).

Bursa subcutanea acromialis (see Fig. 400), often present, just beneath the skin, on the upper surface of the acromion.

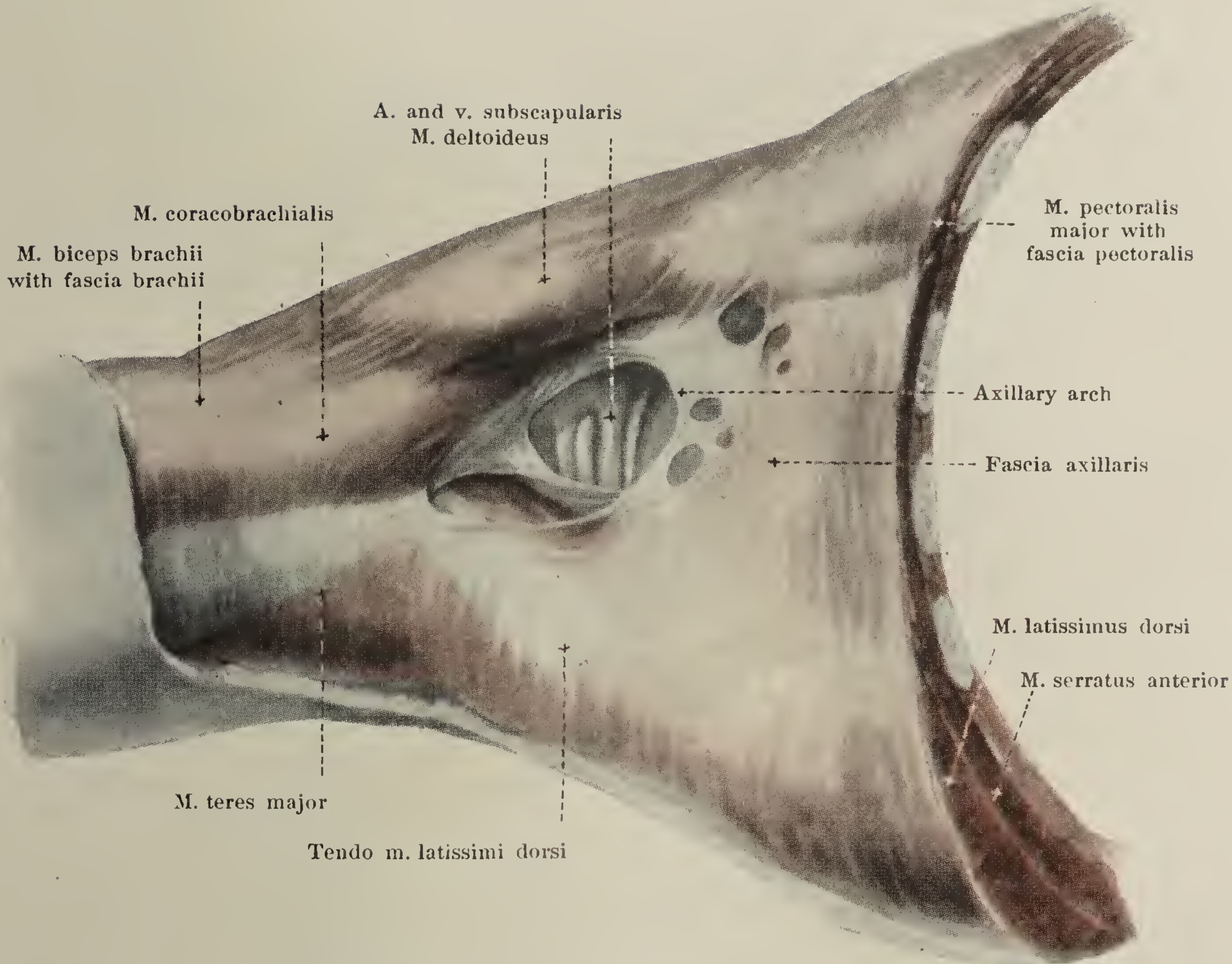

Acromion
Clavicula
M. deltoideus
M. triceps brachii (caput longum)
M. triceps brachii (caput laterale)
M. biceps brachii
M. brachialis
Septum intermusculare laterale
M. brachioradialis
Epicondylus lateralis humeri
Olecranon
M. extensor carpi radialis longus
M. anconaeus
M. extensor carpi ulnaris
M. extensor digitorum communis
M. extensor carpi radialis brevis



394. Muscles of the right axilla, viewed from below.

(The upper arm has been lifted to the horizontal plane.)

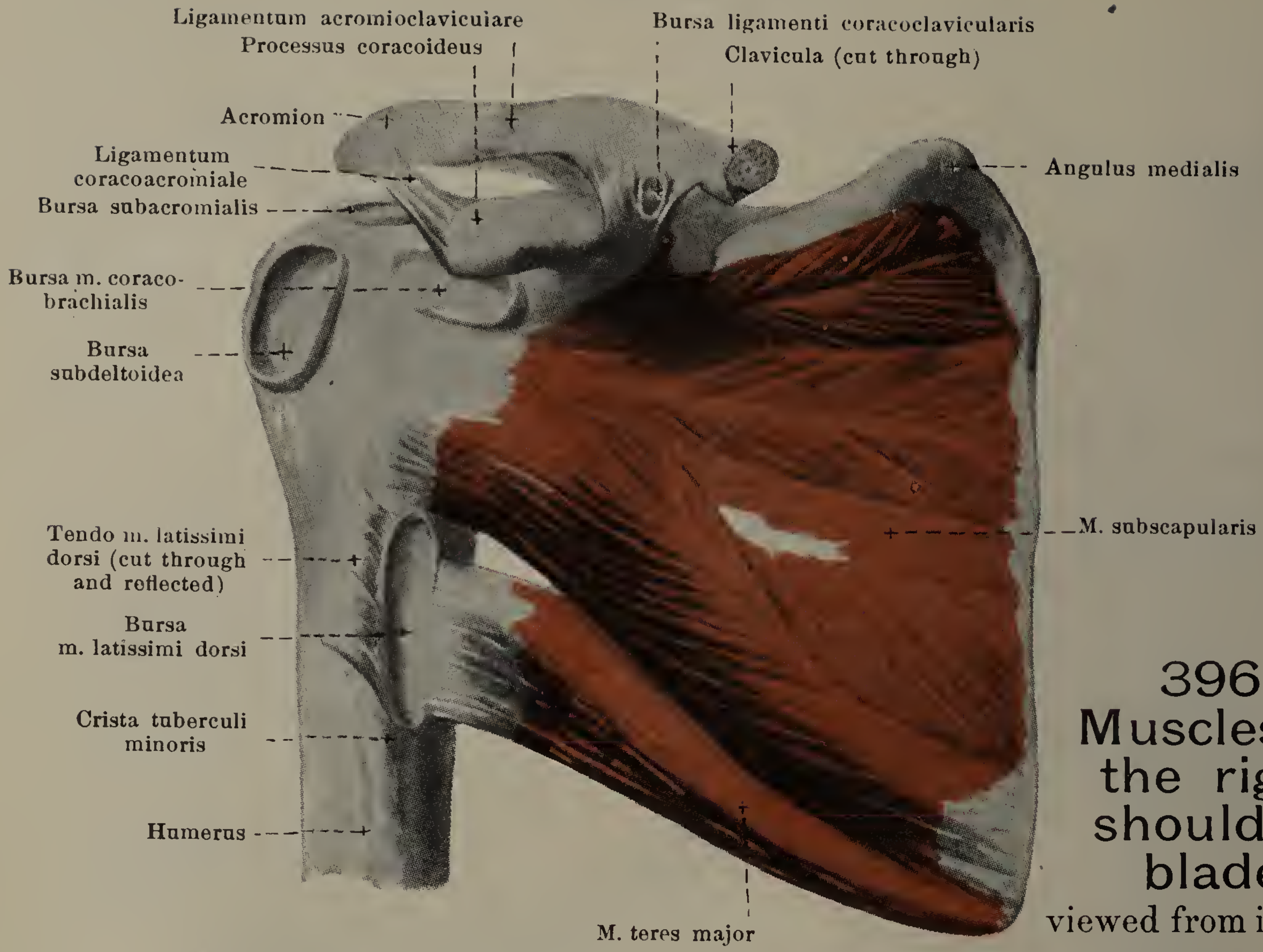
The **axilla,** when the upper arm is maintained in the horizontal plane, has the shape of a three-sided pyramid, the apex of which lies above, below the clavicle, and the base of which corresponds to the lower wall, covered only by skin and fascia. This inferior wall is bounded in front by the m. pectoralis major and sometimes by the m. pectoralis minor, behind by the mm. latissimus dorsi and teres major, medianward by the m. serratus anterior. Its anterior and posterior margins in the uninjured body stand out prominently laterally as the *anterior* and *posterior axillary folds.* The anterior fold is formed chiefly by the m. pectoralis major and sometimes the m. pectoralis minor, the posterior fold by the mm. latissimus dorsi and teres major. The anterior wall is formed by the mm. pectoralis major and pectoralis minor, the posterior wall by the mm. latissimus dorsi, teres major and m. subscapularis, the medial wall by the m. serratus anterior. Along the angle between the anterior and posterior wall lies the m. coracobrachialis; in the groove behind the latter, between it and the muscles of the posterior wall, run the large arm vessels and nerves. The axilla is filled with blood vessels, lymph vessels, lymph glands, nerves, and masses of fat. From the axilla two fissures or spaces filled with conective tissue, known as the two *axillary fissures* or gaps (see Fig. 401), and separated from each other by the caput longum m. tricipitis, lead dorsalward. The *medial axillary fissure* (for the a. and vv. circumflexae scapulae), is triangular and lies medially from the caput longum m. tricipitis, between it, the mm. subscapularis and teres minor and mm. longissimus dorsi and teres major. The *lateral axillary fissure* (for the a. and vv. circumflexae humeri posteriores and n. axillaris), is square-shaped and lies laterally from the caput longum m. tricipitis, between it, the mm. subscapularis and teres minor, collum chirurgicum humeri and mm. latissimus dorsi and teres major.



395. Fasciae of the right axilla, viewed from below.

(The drawing corresponds to Fig. 394; the upper arm is in the horizontal plane.)

Axilla (continued). The anterior surface of the m. pectoralis major is covered over by the thin *fascia pectoralis*. This is more powerful lateralward and extends, from the lower margin of the muscle to the lower margin of the mm. latissimus dorsi and teres major, transversely across the axilla to form the *fascia axillaris*. The latter (see also Fig. 857) is multiply perforated and presents usually a more powerful, curved, fibrous band, the *(fascia-)axillary arch*, which varies much in form and curvature, and extends from the region of the tendon of the m. pectoralis major to that of the m. latissimus dorsi; it is manifoldy connected with these tendons. The fascia or the axillary arch presents not infrequently bundles of muscles *(muscular axillary arch)*, running from the m. latissimus dorsi to the insertion of the m. pectoralis major, less frequently from the m. pectoralis major to the insertion of the m. latissimus dorsi. The fascia axillaris goes over behind into the thin fascia of the mm. latissimus dorsi and teres major, in front into the thin covering of the m. deltoideus and lateralward into the somewhat stronger *fascia brachii*. This forms a sheath for the whole muscular mass of the upper arm (see also Figs. 857—860) and sends on each side a stronger strip to the margo medialis and the margo lateralis humeri, the *septum intermusculare mediale* (O. T. internal intermuscular septum) and the *septum intermusculare laterale* (O. T. external intermuscular septum), the former passing medianward and the latter lateralward between the m. triceps brachii on the one hand and all the other muscles of the upper arm on the other. The medial septum (see Figs. 399 and 404) lies immediately behind the insertion of the m. coracobrachialis, behind the mm. brachialis and pronator teres and in front of the caput mediale m. tricipitis brachii. The lateral septum (see Figs. 393 and 402) begins behind the insertion of the m. deltoideus and runs behind the mm. brachialis, brachioradialis, extensor carpi radialis longus, in front of the caput laterale and caput mediale of the m. triceps brachii. The muscles mentioned arise in part from these septa. The septa contain a great deal of fibres running along the bone, reach until to the epicondyli humeri and are there broadest and strongest.



396. Muscles of the right shoulder-blade, viewed from in front.

M. subscapularis (see also Figs. 394 and 398). Form, flat, triangular, fan-shaped, multipinnate. Position: it fills up almost entirely the fossa subscapularis and passes immediately in front of the shoulder joint. Origin: facies costalis scapulae and fascia subscapularis (see below). Insertion: the fibres converge upward and lateralward and are attached by a short powerful tendon to the tuberculum minus and crista tuberculi minoris of the humerus; on the posterior surface above and laterally they are fused with the capsula articularis humeri; there the ***bursa m. subscapularis*** is found (see p. 198 and Fig. 397). Action: it rolls the arm strongly inward, abducts the arm hanging in the vertical plane, adducts the arm lifted 60° lateralward; the upper portion draws the arm slightly forward, the lower portion draws the arm from the vertical position backward, and draws the lateral lifted arm also forward. Innervation: nn. subscapulares (C_5, C_6 [C_7]).

The **fascia subscapularis** (not shown in drawing) covers, as a thin membrane, the anterior surface of the m. subscapularis and is connected lateralward with the continuation of the fascia brachii, which covers the m. coracobrachialis (see also Fig. 395).

M. teres major (see also Figs. 380, 381, 394 and 397—402). Form: flat-cylindrical. Position: at the margo axillaris of the shoulder-blade, in front covered by the tendon of the m. latissimus dorsi, behind and lateralward partly by the m. latissimus dorsi, partly by the m. deltoideus and caput longum m. tricipitis brachii. Origin: facies dorsalis of the angulus inferior scapulae. Insertion: the fibres run in slight spirals lateralward and upward and are attached by a strong tendon to the crista tuberculi minoris. There, between two layers of the tendon, lies the **bursa m. teretis majoris** (not shown in drawing) which connects sometimes with the bursa m. latissimi dorsi. Action: it draws the arm medianward and backward and rolls it inward; it draws the vertically elevated arm downward. Innervation: nn. subscapulares (C_6, C_7).

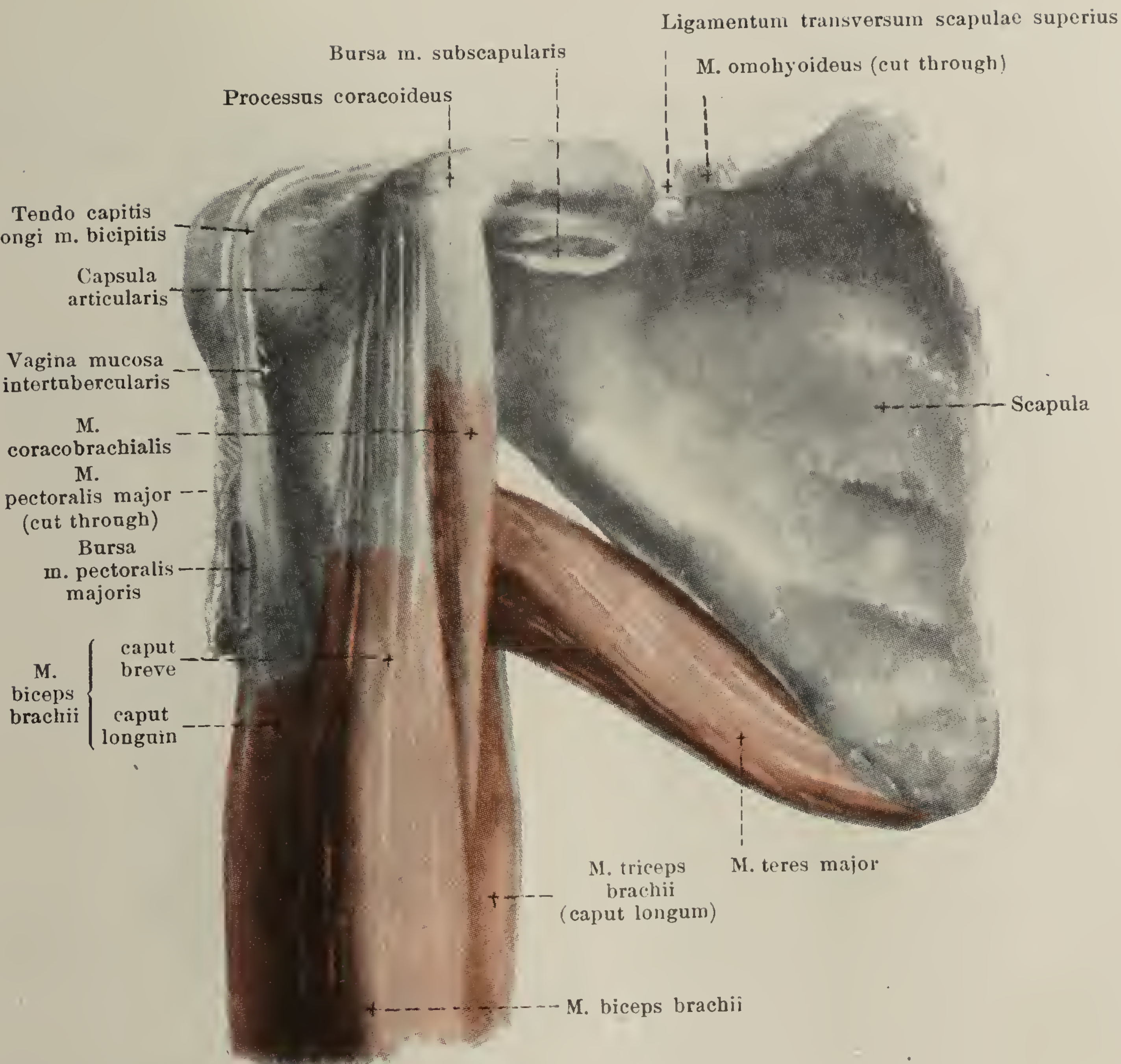
Bursa ligamenti coracoclavicularis, small, often present, between the lig. trapezoideum and the lig. conoideum of the lig. coracoclaviculare.

Bursa subacromialis, large, almost constant, between the acromion and the lig. coracoacromiale on the one hand and the tendon of the m. supraspinatus on the other. It often communicates with the following bursa. It is seldom united before the tendon of the m. supraspinatus with the joint cleft.

Bursa subdeltoidea, large, almost constant, between the m. deltoideus and the tuberculum majus humeri, often communicating with the preceding bursa.

Bursa m. coracobrachialis, of moderate size, almost constant, situated in front of the upper part of the tendon of the m. subscapularis, between it, the proc. coracoideus and the tendon of the m. coracobrachialis.

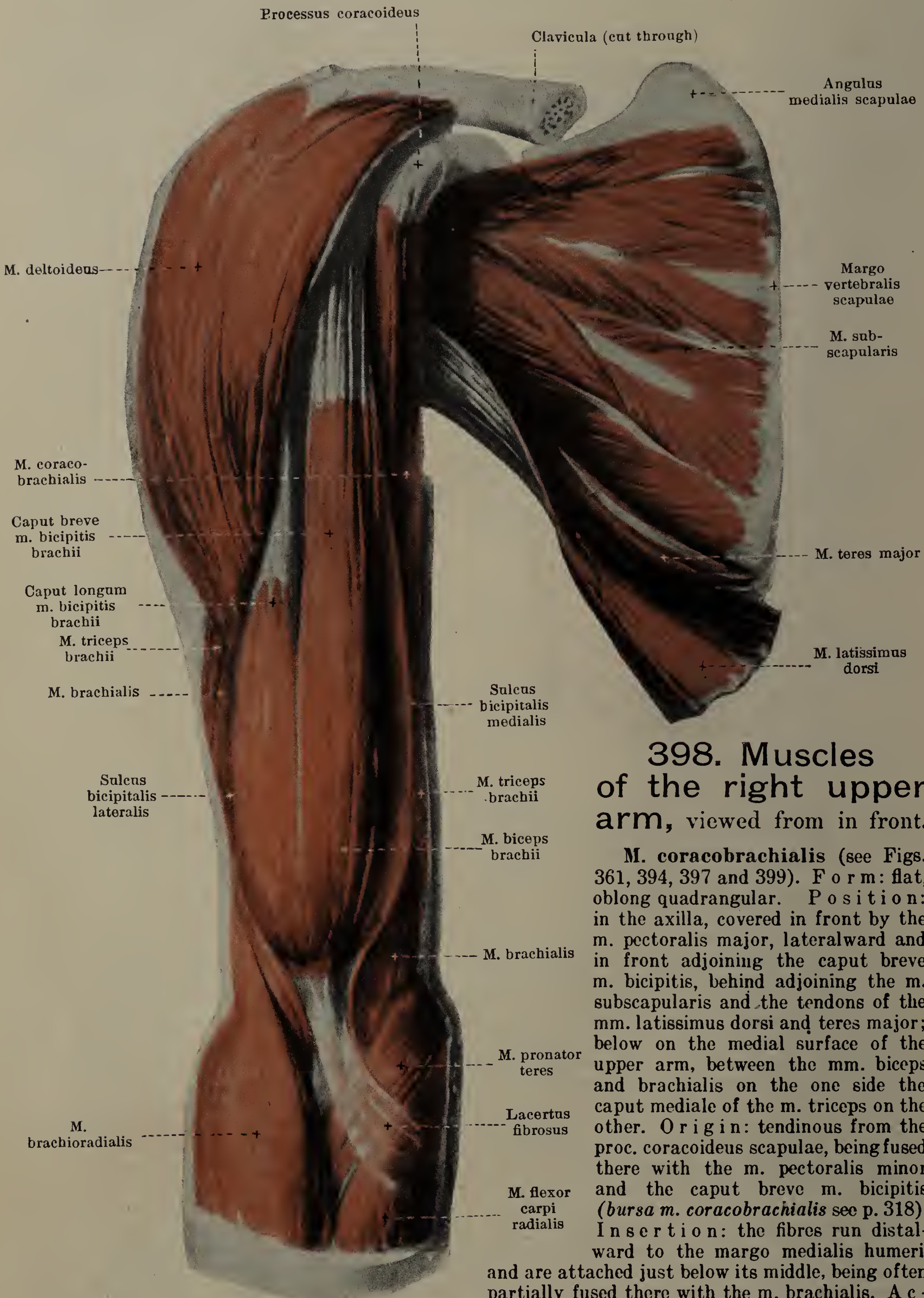
Bursa m. latissimi dorsi, fairly large, oblong, constant, between the tendons of the mm. latissimus dorsi and teres major; sometimes communicating with the bursa m. teretis majoris.


Ligamentum transversum scapulae superius
Bursa m. subscapularis
M. omohyoideus (cut through)
Processus coracoideus
Tendo capitis longi m. bicipitis
Capsula articularis
Vagina mucosa intertubercularis
Scapula
M. coracobrachialis
M. pectoralis major (cut through)
Bursa m. pectoralis majoris
M. biceps brachii
caput breve
caput longum
M. triceps brachii (caput longum)
M. teres major
M. biceps brachii

397. Muscles on the anterior surface of the right shoulder joint, viewed from in front.

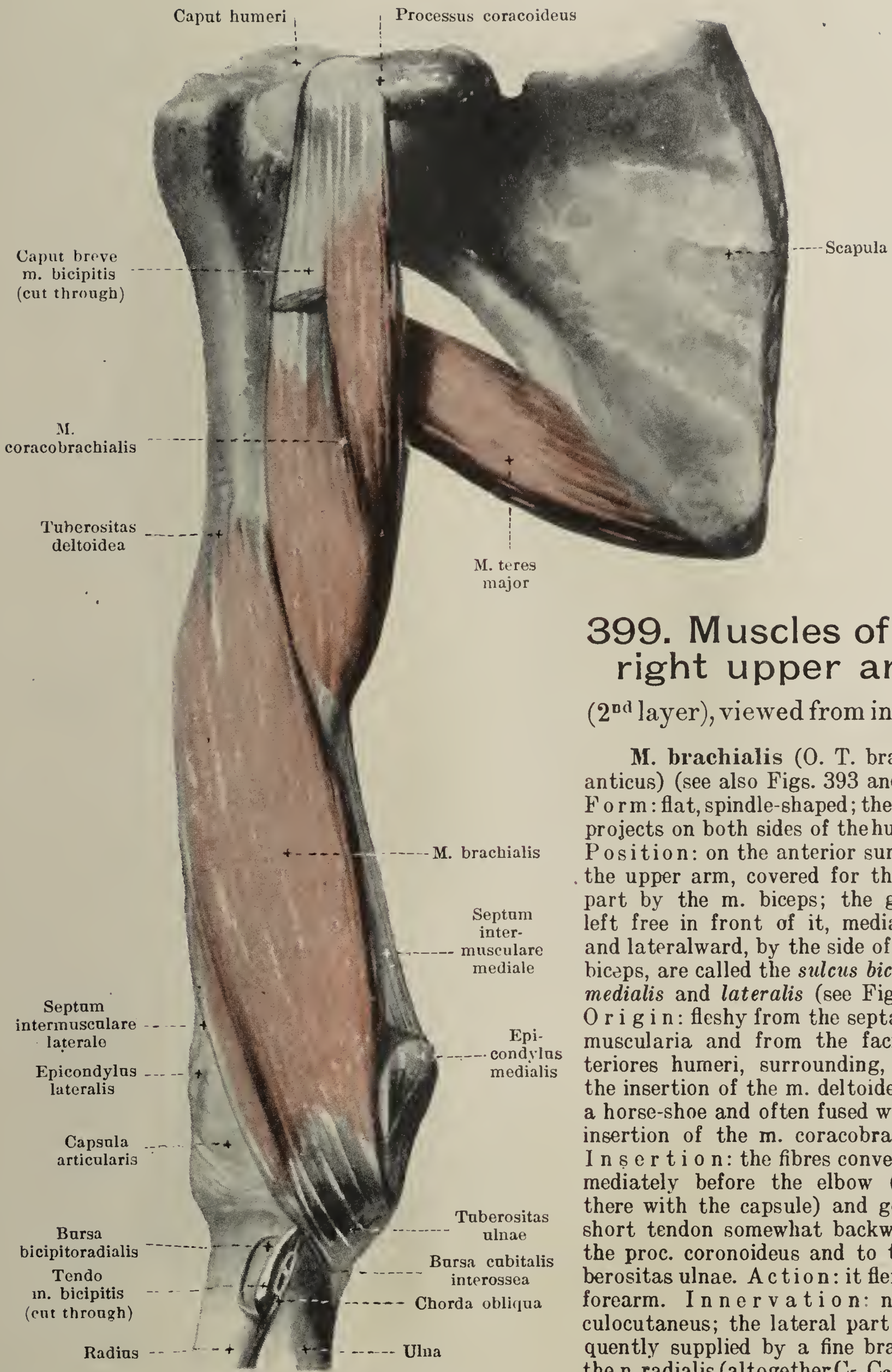
(The clavicula, mm. deltoideus, pectoralis major and subscapularis have been removed.)

M. biceps brachii (see also Figs. 359, 361, 393, 394, 398 and 399). Form: rounded, spindle-shaped, thick. Position: on the anterior surface of the upper arm; above, at its origins, it is covered by the mm. pectoralis major and deltoideus. Origin: by two heads. *Caput longum:* from the tuberositas supraglenoidalis scapulae and from the labrum glenoidale by a long, thin tendon, which extends first lateralward within the cavity of the shoulder joint, then curves, markedly, downward in the sulcus intertubercularis (see also Fig. 282) and is accompanied in its course by a prolongation of the joint-capsule, the *vagina mucosa intertubercularis* (see also p. 198). Below the sulcus intertubercularis the tendon is fixed in its position by the m. pectoralis major (often by a tube-like duplicature of its tendon, see p. 281). *Caput breve:* by a narrow, flat, shorter tendon from the proc. coracoideus, at first fused with the m. coracobrachialis. Insertion: both heads extend downward and unite to form a spindle-shaped muscle-belly, the fibres of which, a little above the elbow joint, go over for the most part into a flatly rounded, thick tendon, partly, also into a superficial thin tendinous plate. The latter, *lacertus fibrosus* (O. T. semilunar fascia), runs obliquely medianward and downward in front of the m. pronator teres and becomes lost in the fascia antebrachii; the tendon proper, bending into the depth, becomes attached to the tuberositas radii *(bursa bicipitoradialis* and *bursa cubitalis interossea* see p. 321). Action: it lifts the upper arm forward and rolls it inward; the caput longum abducts the upper arm, the caput breve adducts it; both flex the forearm and supinate it, especially, when it is flexed. Innervation: n. musculocutaneus (C_5, C_6 [C_7]).



398. Muscles of the right upper arm, viewed from in front.

M. coracobrachialis (see Figs. 361, 394, 397 and 399). Form: flat, oblong quadrangular. Position: in the axilla, covered in front by the m. pectoralis major, lateralward and in front adjoining the caput breve m. bicipitis, behind adjoining the m. subscapularis and the tendons of the mm. latissimus dorsi and teres major; below on the medial surface of the upper arm, between the mm. biceps and brachialis on the one side the caput mediale of the m. triceps on the other. Origin: tendinous from the proc. coracoideus scapulae, being fused there with the m. pectoralis minor and the caput breve m. bicipitis (*bursa m. coracobrachialis* see p. 318). Insertion: the fibres run distalward to the margo medialis humeri and are attached just below its middle, being often partially fused there with the m. brachialis. Action: it lifts the upper arm forward and adducts it; it rolls the arm outward when it is lifted 60° lateralward. Innervation: n. musculocutaneus (C_6, C_7).



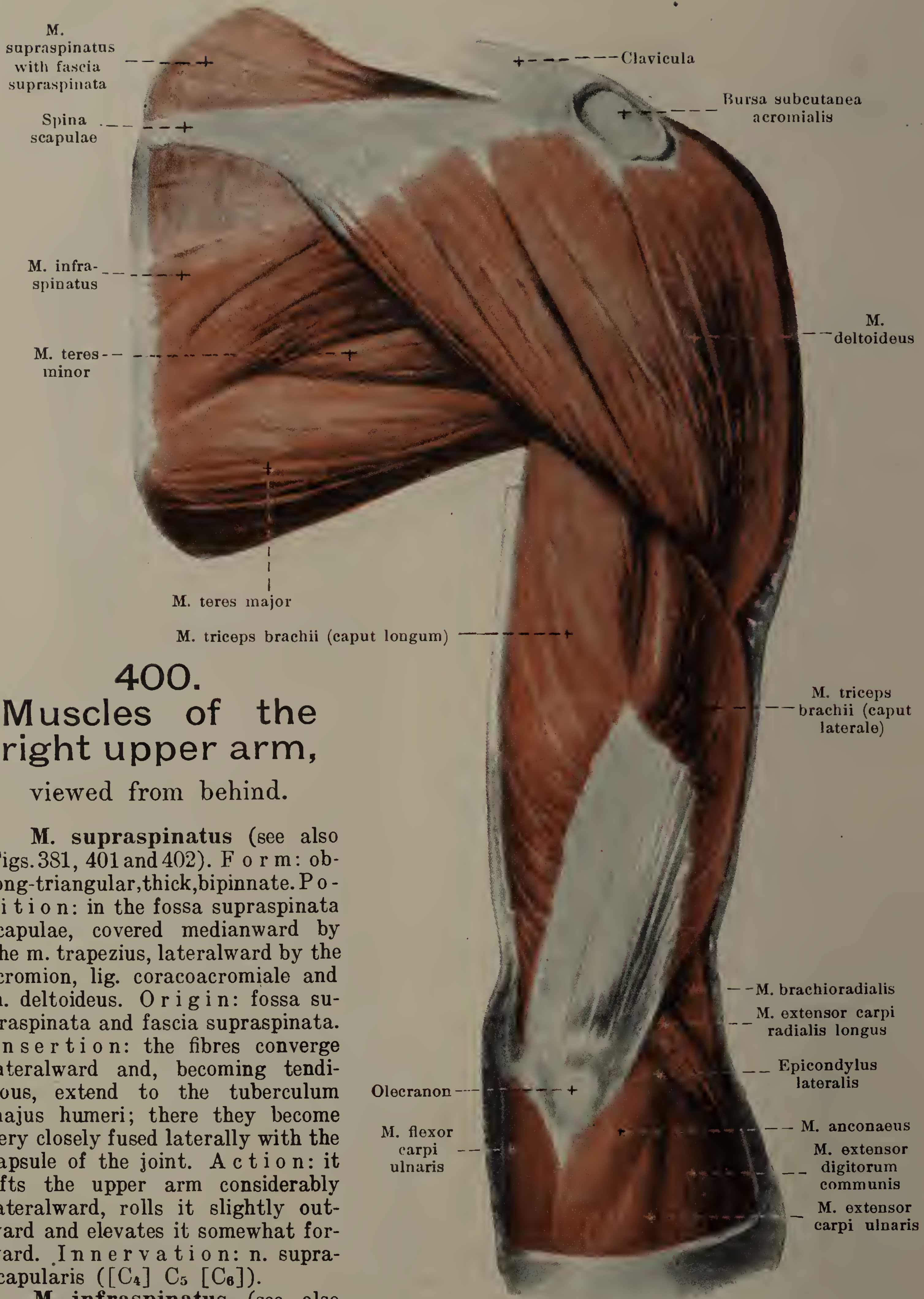
399. Muscles of the right upper arm

(2$^{\text{nd}}$ layer), viewed from in front.

M. brachialis (O. T. brachialis anticus) (see also Figs. 393 and 398). Form: flat, spindle-shaped; the muscle projects on both sides of the humerus. Position: on the anterior surface of the upper arm, covered for the most part by the m. biceps; the grooves left free in front of it, medianward and lateralward, by the side of the m. biceps, are called the *sulcus bicipitalis medialis* and *lateralis* (see Fig. 398). Origin: fleshy from the septa intermuscularia and from the facies anteriores humeri, surrounding, above, the insertion of the m. deltoideus like a horse-shoe and often fused with the insertion of the m. coracobrachialis. Insertion: the fibres converge immediately before the elbow (united there with the capsule) and go by a short tendon somewhat backward to the proc. coronoideus and to the tuberositas ulnae. Action: it flexes the forearm. Innervation: n. musculocutaneus; the lateral part is frequently supplied by a fine branch of the n. radialis (altogether C_5, C_6 [C_7]).

Bursa bicipitoradialis, constant; between the tuberositas radii and the tendon of the m. biceps.

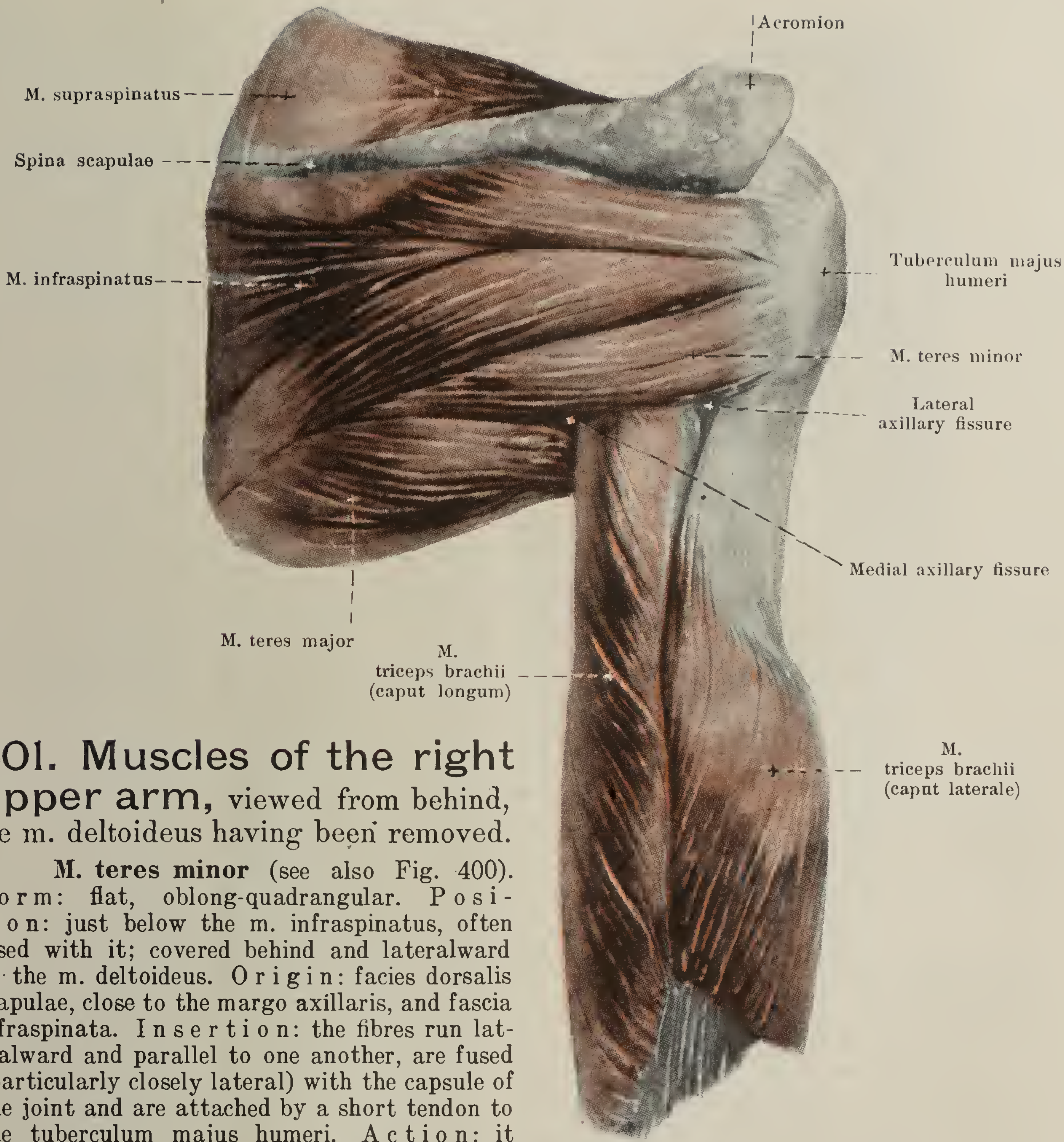
Bursa cubitalis interossea, often present in later life; adjoining, lateralward, the tendon of the m. biceps, medianward, the ulna and chorda obliqua, behind, the m. supinator.


M. supraspinatus with fascia supraspinata
Spina scapulae
M. infraspinatus
M. teres minor
M. teres major
M. triceps brachii (caput longum)
Clavicula
Bursa subcutanea acromialis
M. deltoideus
M. triceps brachii (caput laterale)
M. brachioradialis
M. extensor carpi radialis longus
Epicondylus lateralis
Olecranon
M. flexor carpi ulnaris
M. anconaeus
M. extensor digitorum communis
M. extensor carpi ulnaris

400.
Muscles of the right upper arm,
viewed from behind.

M. supraspinatus (see also Figs. 381, 401 and 402). Form: oblong-triangular, thick, bipinnate. Position: in the fossa supraspinata scapulae, covered medianward by the m. trapezius, lateralward by the acromion, lig. coracoacromiale and m. deltoideus. Origin: fossa supraspinata and fascia supraspinata. Insertion: the fibres converge lateralward and, becoming tendinous, extend to the tuberculum majus humeri; there they become very closely fused laterally with the capsule of the joint. Action: it lifts the upper arm considerably lateralward, rolls it slightly outward and elevates it somewhat forward. Innervation: n. suprascapularis ([C_4] C_5 [C_6]).

M. infraspinatus (see also Figs. 380, 381 and 401). Form: flat, oblong-triangular, thick, bipinnate. Position: in the fossa infraspinata scapulae, partially covered medianward by the m. trapezius, lateralward by the m. deltoideus. Origin: fossa infraspinata and fascia infraspinata. Insertion: the fibres converge as they pass lateralward to become inserted by a strong tendon at the tuberculum majus humeri (*bursa m. infraspinati* see p. 324); they are there closely fused, particularly laterally, with the capsule of the joint. Action: it rolls the upper arm outward; and draws it slightly forward; the vertically hanging arm abducts the upper, adducts slightly the lower part; when the arm is lifted 60° lateralward, the entire muscle abducts. Innervation: n. suprascapularis ([C_4] C_5, C_6).



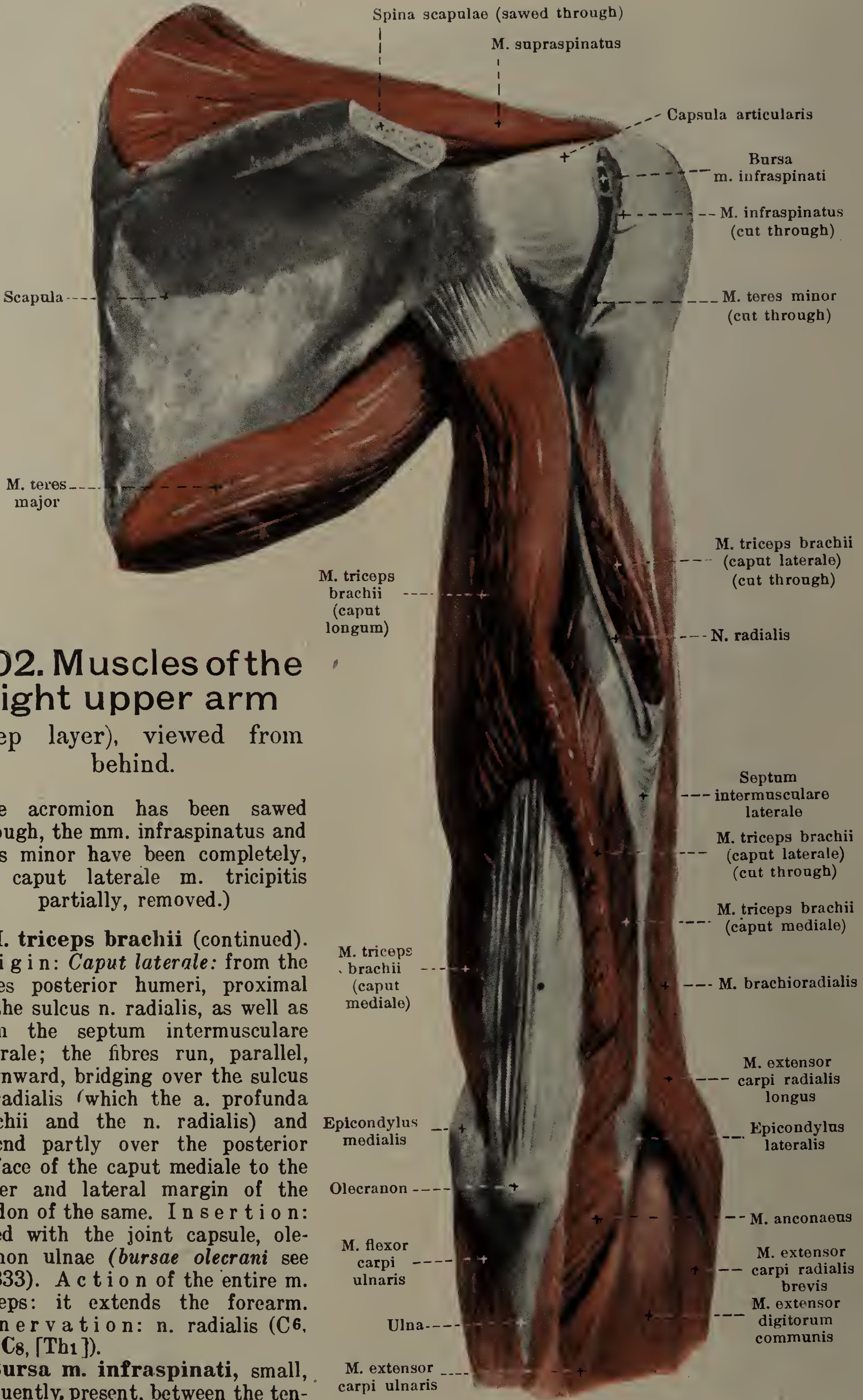
401. Muscles of the right upper arm, viewed from behind, the m. deltoideus having been removed.

M. teres minor (see also Fig. 400). Form: flat, oblong-quadrangular. Position: just below the m. infraspinatus, often fused with it; covered behind and lateralward by the m. deltoideus. Origin: facies dorsalis scapulae, close to the margo axillaris, and fascia infraspinata. Insertion: the fibres run lateralward and parallel to one another, are fused (particularly closely lateral) with the capsule of the joint and are attached by a short tendon to the tuberculum majus humeri. Action: it rolls the upper arm outward, adducts it and lifts slightly forward the arm hanging down, a little backward the laterally elevated arm. Innervation: n. axillaris (C_5, C_6 [C_7]).

Fascia supraspinata (see Fig. 400) is a powerful fascia, distinctly striated medianward, which covers the m. supraspinatus; it is fused medianward with the margo superior, the margo vertebralis and the spina scapulae and lateralward becomes lost.

The **fascia infraspinata** (see Figs. 380 and 381) is attached to the margo vertebralis and to the spina scapulae, is stronger medianward, covers the mm. infraspinatus and teres minor and reaches lateralward the humerus.

M. triceps brachii (see also Figs. 393, 394, 400 and 402). Form: flat, oblong-quadrangular. Position: it occupies the whole posterior surface of the upper arm. Origin: by three heads. *Caput longum:* by a flat tendon from the tuberositas infraglenoidalis scapulae; it runs downward between the mm. teres minor and teres major, the fibres being parallel, is partly covered above by the m. deltoideus and overlaps the caput mediale, in part, from behind and medianward; below it continues in a tendon plate attached to the tendon area. Action: adducts the upper arm and draws it somewhat backward; it extends the forearm. *Caput mediale* (see Fig. 402): from the facies posterior humeri, distal from the sulcus n. radialis, as well as from the septa intermuscularia mediale et laterale; the fibres reach below close to the m. anconaeus and run, converging somewhat, to a large quadrangular flat tendon, which begins in the middle of the upper arm (continued on p. 324).


Spina scapulae (sawed through)
M. supraspinatus
Capsula articularis
Bursa m. infraspinati
M. infraspinatus (cut through)
Scapula
M. teres minor (cut through)
M. teres major
M. triceps brachii (caput laterale) (cut through)
M. triceps brachii (caput longum)
N. radialis
Septum intermusculare laterale
M. triceps brachii (caput laterale) (cut through)
M. triceps brachii (caput mediale)
M. triceps brachii (caput mediale)
M. brachioradialis
M. extensor carpi radialis longus
Epicondylus medialis
Epicondylus lateralis
Olecranon
M. anconaeus
M. flexor carpi ulnaris
M. extensor carpi radialis brevis
Ulna
M. extensor digitorum communis
M. extensor carpi ulnaris

402. Muscles of the right upper arm (deep layer), viewed from behind.

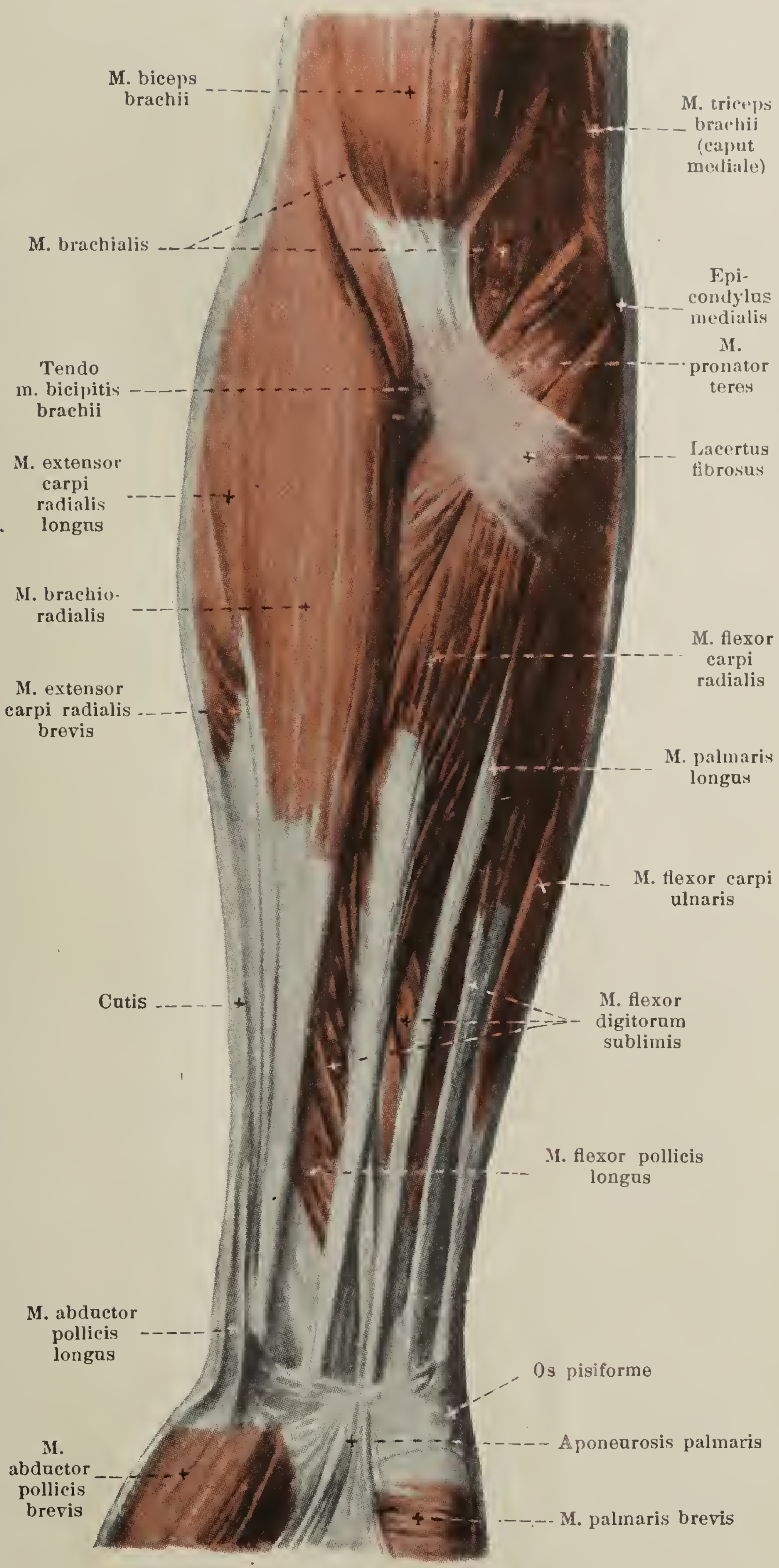
(The acromion has been sawed through, the mm. infraspinatus and teres minor have been completely, the caput laterale m. tricipitis partially, removed.)

M. triceps brachii (continued). Origin: *Caput laterale:* from the facies posterior humeri, proximal to the sulcus n. radialis, as well as from the septum intermusculare laterale; the fibres run, parallel, downward, bridging over the sulcus n. radialis (which the a. profunda brachii and the n. radialis) and extend partly over the posterior surface of the caput mediale to the upper and lateral margin of the tendon of the same. Insertion: fused with the joint capsule, olecranon ulnae (*bursae olecrani* see p. 333). Action of the entire m. triceps: it extends the forearm. Innervation: n. radialis (C_6, C_7, C_8, [Th_1]).

Bursa m. infraspinati, small, frequently present, between the tendon of insertion of the m. infraspinatus and the capsule of the joint.

403. Muscles of the right forearm,

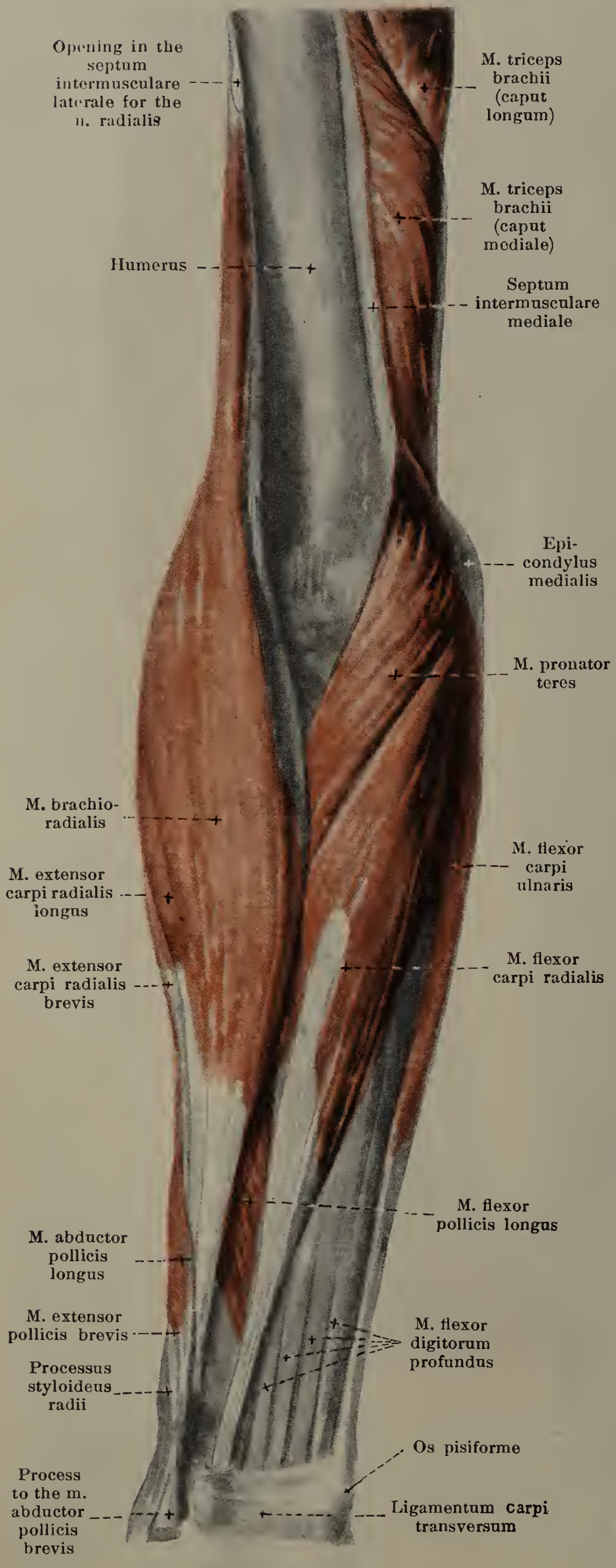
viewed from in front.


M. biceps brachii
M. triceps brachii (caput mediale)
M. brachialis
Epicondylus medialis
M. pronator teres
Tendo m. bicipitis brachii
Lacertus fibrosus
M. extensor carpi radialis longus
M. brachioradialis
M. flexor carpi radialis
M. extensor carpi radialis brevis
M. palmaris longus
M. flexor carpi ulnaris
Cutis
M. flexor digitorum sublimis
M. flexor pollicis longus
M. abductor pollicis longus
Os pisiforme
Aponeurosis palmaris
M. abductor pollicis brevis
M. palmaris brevis

M. brachioradialis (O. T. supinâtor longus) (see also Figs. 404, 408 and 409). Form: flat, broad above, pointed below. Position: superficial on the lateral surface of the upper arm and the volar surface of the forearm. Origin: margo lateralis humeri and septum intermusculare laterale. Insertion: above, it runs between the m. triceps and the m. brachialis; below, it is bounded behind by the m. extensor carpi radialis longus, ulnarward by the mm. pronator teres and flexor carpi radialis and becomes attached by a long, thin, flat tendon, beginning in the middle of the forearm, close above the proc. styloideus radii. Action: it flexes the forearm powerfully; when it is flexed at a right angle, it brings the hand in an intermediate position which is neighboring the extreme pronation; when the forearm is greatly flexed, it pronates powerfully; when the forearm is extended, it supinates the same. Innervation: n. radialis (C_5, C_6).

M. palmaris longus (see also Fig. 413) (is frequently absent). Form: spindle-shaped, narrow. Position: superfical on the volar surface of the forearm. Origin: epicondylus medialis humeri and fascia antebrachii, fused with its neighbors. Insertion: it extends above between the mm. flexores carpi radialis and ulnaris on the m. flexor digitorum sublimis, then downward and radialward upon the latter and goes over by a long, thin tendon, in front of the lig. carpi transversum, into the aponeurosis palmaris. Action: it pronates the forearm; it flexes the hand and makes the aponeurosis palmaris tense. Innervation: n. medianus (C_7, C_8, Th_1).

M. pronator teres (O. T. pronator radii teres) (see also Figs. 404 and 406). Form: oblong-quadrangular. Position: flexure of the elbow and volar surface of the forearm. Origin: by two heads: partly from the septum intermusculare mediale and the epicondylus medialis humeri *(caput humerale)*, partly from the proc. coronoideus ulnae *(caput ulnare)* (communly weaker); the two heads are usually separated by the n. medianus. Insertion: the fibres run, parallel, obliquely radialward and downward to bevome attached by a short tendon to the facies volaris and lateralis radii. Action: it pronates the forearm and flexes it. Innervation: n. medianus (C_6, C_7).


Opening in the septum intermusculare laterale for the n. radialis
Humerus
M. brachio-radialis
M. extensor carpi radialis longus
M. extensor carpi radialis brevis
M. abductor pollicis longus
M. extensor pollicis brevis
Processus styloideus radii
Process to the m. abductor pollicis brevis
M. triceps brachii (caput longum)
M. triceps brachii (caput mediale)
Septum intermusculare mediale
Epi-condylus medialis
M. pronator teres
M. flexor carpi ulnaris
M. flexor carpi radialis
M. flexor pollicis longus
M. flexor digitorum profundus
Os pisiforme
Ligamentum carpi transversum

404. Muscles of the right forearm,

viewed from in front.

(The mm. biceps, brachialis, palmaris longus and flexor digitorum sublimis have been removed.)

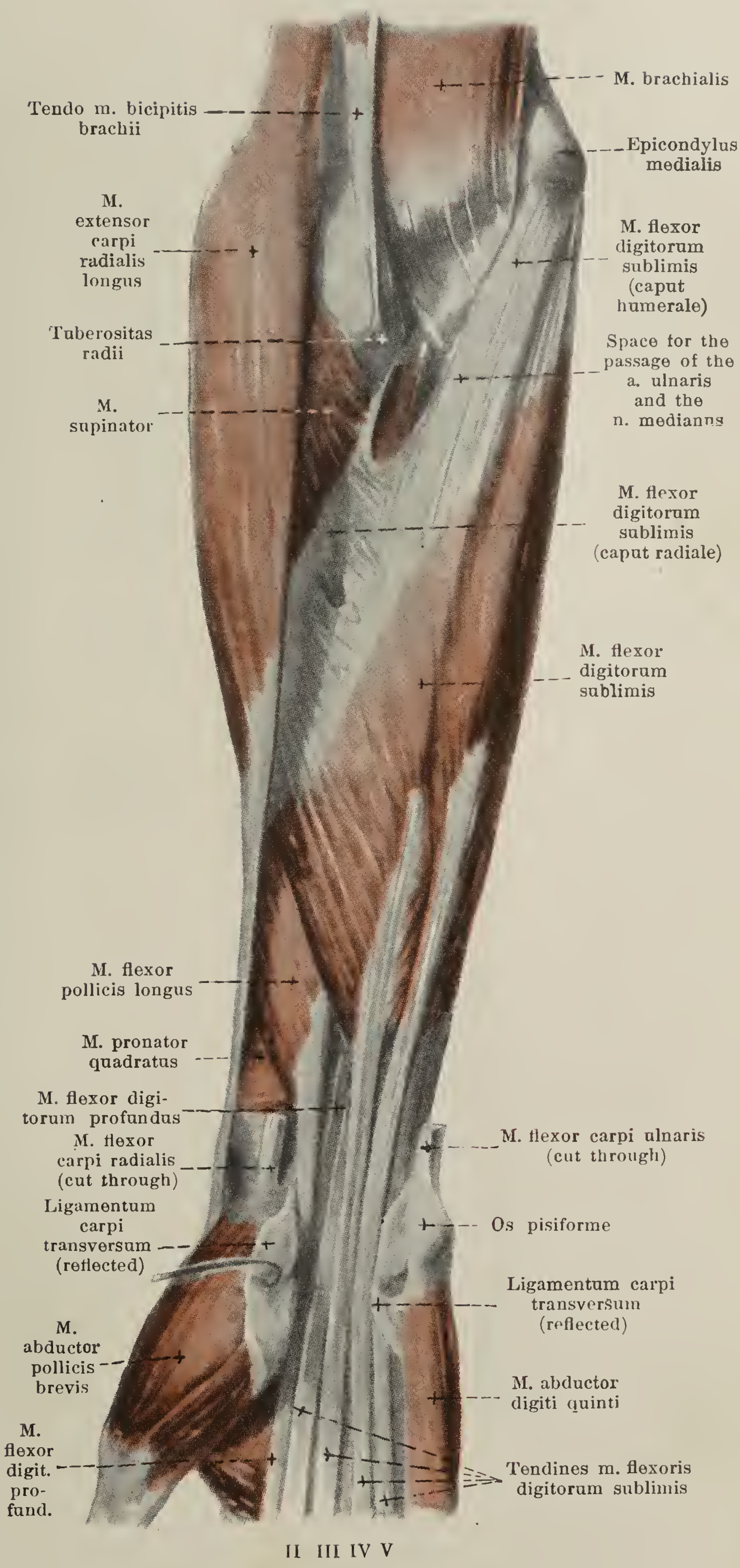
M. flexor carpi radialis (see also Fig. 403). Form: flat, oblong-spindle-shaped, bipinnate in its lower half. Position: superficial on the volar surface of the forearm. Origin: epicondylus medialis humeri and fascia antebrachii, fused with its neighbors. Insertion: the fibres go, at first diverging, between mm. pronator teres and palmaris longus, radialward and downward, and then become attached bipinnate to a powerful tendon running from the middle of the forearm between the mm. brachioradialis and palmaris longus to the hand, where the tendon, covered by the lig. carpi transversum (in a separate canal of it, see p. 335), lies in the groove of the os multangulum majus; finally, covered by the tendon of the m. flexor pollicis longus, it goes to the basis oss. metacarpalis II and III (see Fig. 406). In the hand the **bursa m. flexoris carpi radialis** (see Fig. 417) lies between the bone and the tendon Action: it pronates the forearm, flexes and abducts the hand. Innervation: n. medianus (C_6, C_7 [C_8]).

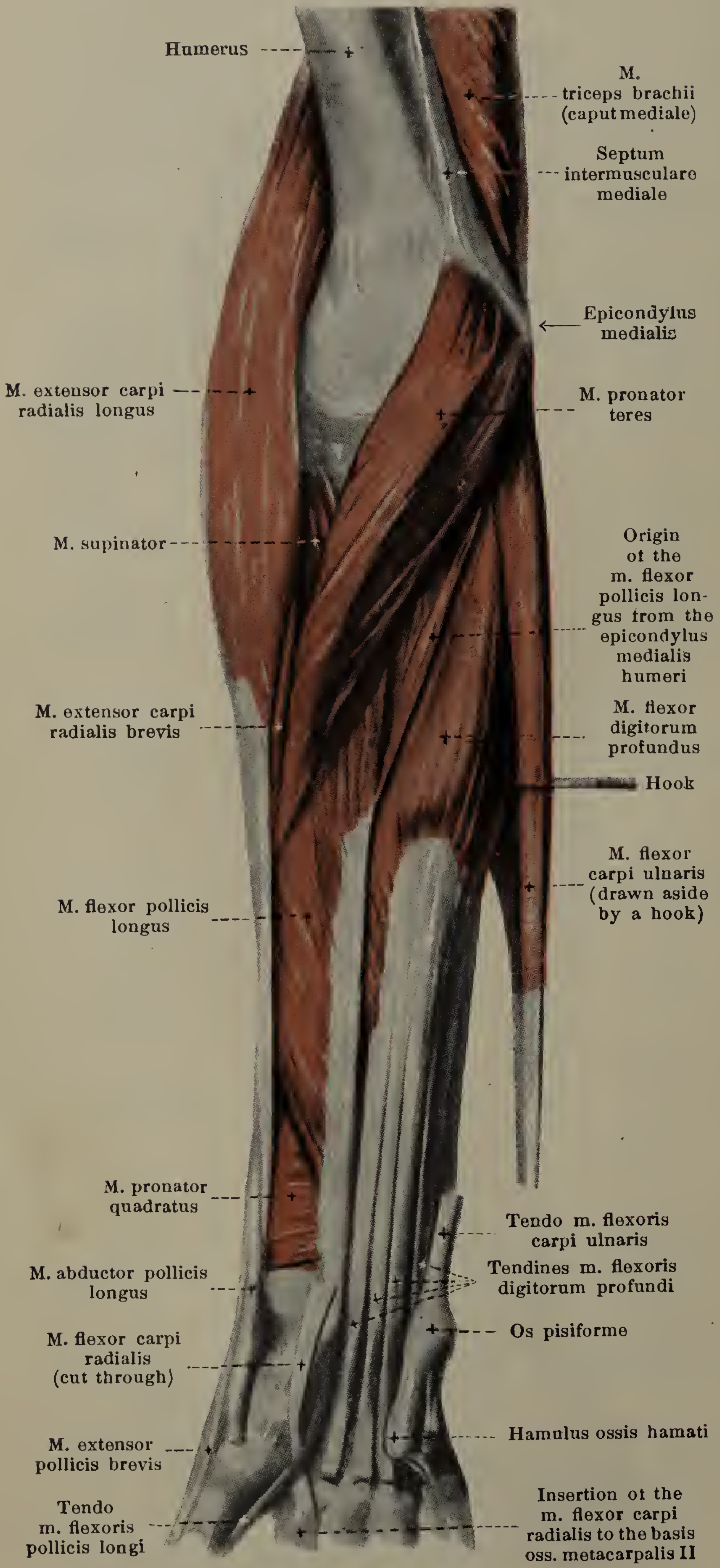
M. flexor carpi ulnaris (see also Figs. 403, 406, 409 and 411). Form: flat, oblong-triangular; above it forms, with its radial, anterior surface, a groove, in which lies the ulnar part of the m. flexor digitorum profundus. Position: superficial on the ulnar margin of the forearm. Origin: partly from the epicondylus medialis humeri and from the fascia antebrachii, fused with its neighbors *(caput humerale)*, partly by a long, flat, thin tendon-plate which is fused with the fascia antebrachii, from the posterior surface of the olecranon and from the margo dorsalis ulnae *(caput ulnare)*. Insertion: it runs distalward, coming in contact radialward with the m. flexor digitorum sublimis and is attached by a long, powerful tendon to the os pisiforme; the **bursa m. flexoris carpi ulnaris** (not shown in figure) is frequently to be found there. Action: it flexes and adducts the hand. Innervation: n. ulnaris (C_8, Th_1).

405. Muscles of the right forearm (2nd layer), viewed from in front.

(The mm. brachioradialis, pronator teres, flexor carpi radialis, palmaris longus and flexor carpi ulnaris have been removed; the lig. carpi transversum has been cut through.)

M. flexor digitorum sublimis (see also Fig. 403). Form: flat, spindle-shaped, partly bipinnate. Position: on the volar surface of the forearm; above, it is covered by the mm. brachioradialis, pronator teres, flexor carpi radialis, palmaris longus and flexor carpi ulnaris; below, it lies between the mm. flexores carpi radialis et ulnaris, coming to the surface and overlapped only by the m. palmaris longus. Origin: partly from the epicondylus medialis humeri and from the tuberositas ulnae, fused with its neighbors *(caput humerale)*, partly from the facies volaris radii *(caput radiale)* and, between them, from a tendinous arch, which bridges over the a. and vv. ulnares and the n. medianus. Insertion: the muscle divides distally in four, different widely separated muscle-bellies, from the distal ends of which emerge four flat, long tendons; these extend, so that those destined for the 3rd and 4th finger lie superficially, beneath the lig. carpi transversum to the hand; thence all diverge to the volar surface of the heads of the ossa metatarsalia II—V and thence run along the volar surface of the phalanges (see Figs. 414 and 415). On the volar surface of the first phalanx each tendon divides into two halves, which surround the corresponding tendon of the m. flexor digitorum profundus; the two halves partly cross *(chiasma tendinum)* and unite behind the latter, and become attached to the volar surface of the second phalanx. Action: it flexes the hand and adducts it slightly, approaches the fingers about to the middle finger, and flexes the first and the 2nd phalanx of the 2nd to 5th finger. Innervation: n. medianus ([C_6, C_7] C_8, Th_1).


Tendo m. bicipitis brachii
M. extensor carpi radialis longus
Tuberositas radii
M. supinator
M. flexor pollicis longus
M. pronator quadratus
M. flexor digitorum profundus
M. flexor carpi radialis (cut through)
Ligamentum carpi transversum (reflected)
M. abductor pollicis brevis
M. flexor digit. profund.
M. brachialis
Epicondylus medialis
M. flexor digitorum sublimis (caput humerale)
Space for the passage of the a. ulnaris and the n. medianus
M. flexor digitorum sublimis (caput radiale)
M. flexor digitorum sublimis
M. flexor carpi ulnaris (cut through)
Os pisiforme
Ligamentum carpi transversum (reflected)
M. abductor digiti quinti
Tendines m. flexoris digitorum sublimis
II III IV V


Humerus
M. triceps brachii (caput mediale)
Septum intermusculare mediale
Epicondylus medialis
M. extensor carpi radialis longus
M. pronator teres
M. supinator
Origin of the m. flexor pollicis longus from the epicondylus medialis humeri
M. extensor carpi radialis brevis
M. flexor digitorum profundus
Hook
M. flexor carpi ulnaris (drawn aside by a hook)
M. flexor pollicis longus
M. pronator quadratus
Tendo m. flexoris carpi ulnaris
M. abductor pollicis longus
Tendines m. flexoris digitorum profundi
Os pisiforme
M. flexor carpi radialis (cut through)
M. extensor pollicis brevis
Hamulus ossis hamati
Tendo m. flexoris pollicis longi
Insertion of the m. flexor carpi radialis to the basis oss. metacarpalis II

406. Muscles of the right forearm

(3rd layer),

viewed from in front.

(The mm. biceps, brachialis, brachioradialis, flexor carpi radialis, palmaris longus and flexor digitorum sublimis have been removed; the lig. carpi transversum has also been removed.)

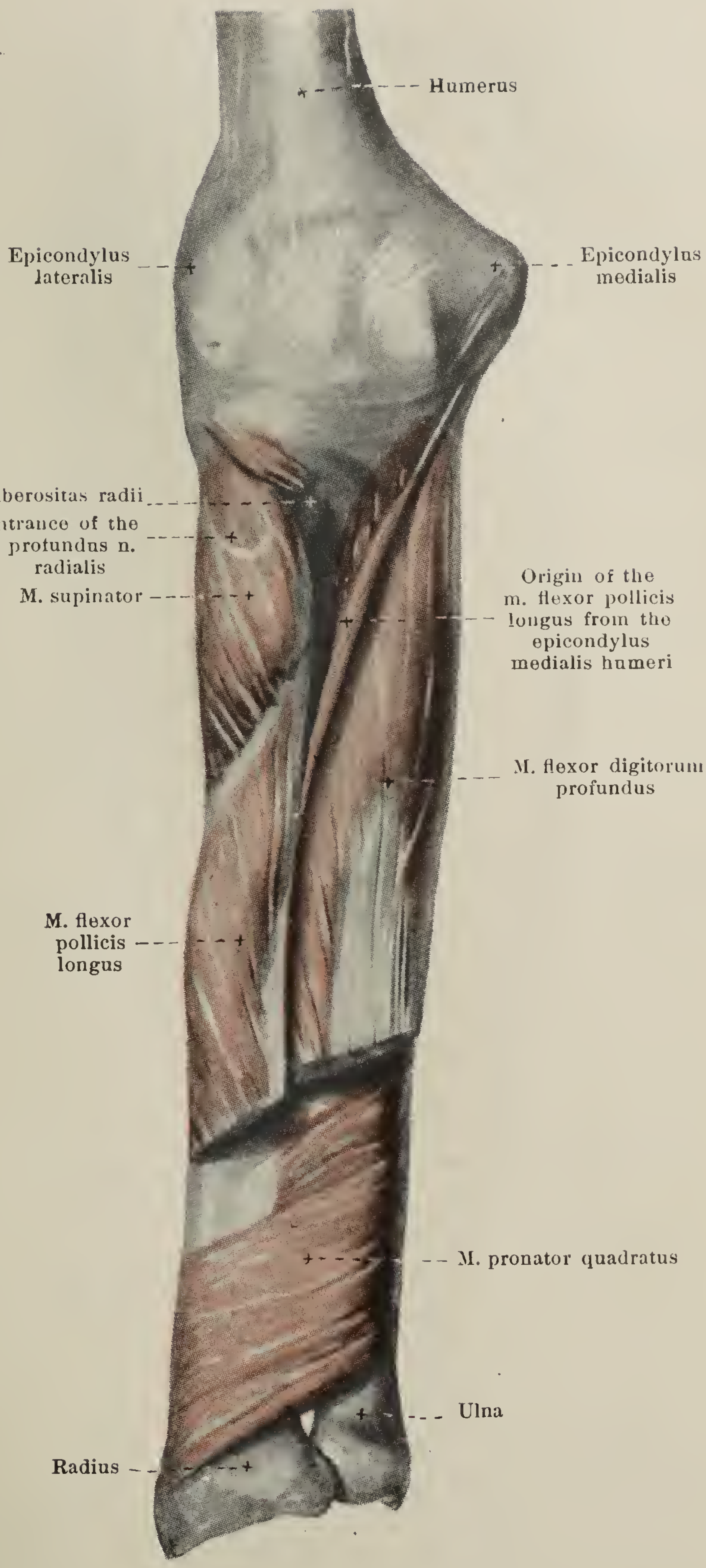
M. flexor digitorum profundus (see also Figs. 404, 405 and 407). Form: flat, spindle-shaped. Position: on the volar surface of the forearm, directly upon the ulna and m. pronator quadratus; completely covered by the mm. pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum sublimis and flexor carpi ulnaris. Origin: facies volaris and ulnaris ulnae and membrana interossea antebrachii and fascia antebrachii (inner surface of the sheet of origin of the caput ulnare of the m. flexor carpi ulnaris). Insertion: the fibres run almost parallel downward; from the muscle belly, from the middle of the forearm on, go off four long, flat tendons, which go beneath and along with the tendons of the m. flexor sublimis, under the lig. carpi transversum to the hollow of the hand and thence to the 2nd—5th finger; each tendon runs, at the level of the 1st phalanx, between the halves of the corresponding tendon of the m. flexor sublimis to the base of the 3rd phalanx (see Fig. 415). Action: it flexes the hand and adducts it slightly, flexes the 1st—3rd phalanx of the 2nd—5th finger. Innervation: for the 3rd, 4th and 5th finger: n. ulnaris; for the 2nd, 3rd and 4th finger: n. interosseus volaris of the n. medianus (total C_6, C_7, C_8, Th_1).

M. flexor pollicis longus (see also Figs. 405 and 407). Form: flat, oblong-triangular, unipinnate. Position: on the volar surface of the forearm, immediately upon the radius and the m. pronator quadratus; covered by the mm. pronator teres, brachioradialis, flexor carpi radialis and flexor digitorum sublimis. Origin: facies volaris radii and usually, by a thin bundle, from the epicondylus medialis humeri. Insertion: the fibres run to a long tendon beginning ulnarward; this extends, along with the tendons of the mm. flexores digitorum, below the lig. carpi transversum to the hand, then in the groove of the m. flexor pollicis brevis to the base of the 2nd phalanx of the thumb (see Fig. 415). Action: it flexes the hand and abducts it slightly, turns the thumb dorsalward and flexes its 2nd phalanx. Innervation: n. interosseus volaris of the n. medianus (C_6, C_7, C_8).

407. Muscles of the right forearm

(4th layer), viewed from in front.

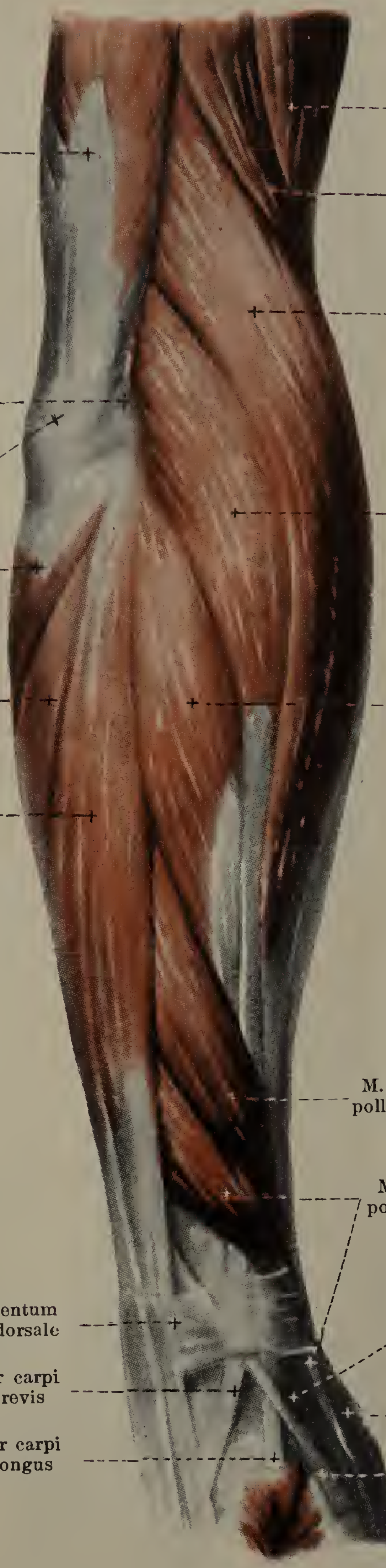
(The mm. flexor digitorum profundus and flexor pollicis longus have been partially, all the more superficial muscles completely, removed.)


Humerus
Epicondylus lateralis
Epicondylus medialis
Tuberositas radii
Entrance of the r. profundus n. radialis
M. supinator
Origin of the m. flexor pollicis longus from the epicondylus medialis humeri
M. flexor digitorum profundus
M. flexor pollicis longus
M. pronator quadratus
Ulna
Radius

M. pronator quadratus (see also Fig. 405). Form: flat, quadrangular. Position: on the volar surface of the forearm near the wrist, immediately upon the radius, the ulna and the membrana interossea; covered by all the flexor muscles going to the hand. Origin: facies volaris ulnae. Insertion: the fibres run parallel, radialward and somewhat downward to the facies volaris radii. Action: it pronates the forearm. Innervation: n. interosseus volaris of the n. medianus (C_6, C_7, C_8, Th_1).

M. supinator (O. T. supinator brevis) (see also Figs. 405, 406, 410 and 411). Form: flat, bent as a hollow groove, quadrangular; it is obliquely pierced by the r. profundus n. radialis (see Fig. 877). Position: close below the elbow joint on the volar, radial and dorsal surface of the forearm, immediately upon the radius, covered by the mm. brachioradialis, extensores carpi et digitorum communis and anconaeus. Origin: epicondylus lateralis humeri, lig. collaterale radiale of the elbow joint and crista m. supinatoris ulnae. Insertion: the fibres run obliquely downward to the facies volaris, radialis and dorsalis of the radius, partially surrounding this bone in a curve. Action: it supinates the forearm. Innervation: ramus profundus n. radialis ([C_5] C_6, C_7, C_8).

M. extensor carpi radialis longus (O. T. extensor carpi radialis longior) (see Figs. 403—406, 408—410 and 412). Form: flat, oblong-spindle-shaped. Position: usually superficial on the radial side of the forearm, covered in front by the m. brachioradialis, bounded behind by the m. extensor carpi radialis brevis. Origin: septum intermusculare laterale, margo lateralis and epicondylus lateralis humeri. Insertion: the fibres run downward and converge in the middle of the forearm to form a long, flat tendon, which extends upon the facies radialis radii (there partly crossed by the mm. abductor pollicis longus and extensor pollicis brevis) under the lig. carpi dorsale (through its second compartment) to the dorsal surface of the basis oss. metacarpalis II; at the wrist the tendon of the m. extensor pollicis longus crosses over it. Action: it flexes the forearm, supinates the extended and pronates the flexed forearm; it abducts and extends the hand. Innervation: ramus profundus n. radialis ([C_5] C_6, C_7, C_8).


M. triceps brachii
M. biceps brachii
M. brachialis
M. brachio-radialis
Epicondylus lateralis
Olecranon
M. extensor carpi radialis longus
M. anconaeus
M. extensor carpi ulnaris
M. extensor carpi radialis brevis
M. extensor digitorum communis
M. abductor pollicis longus
M. extensor pollicis brevis
Ligamentum carpi dorsale
Location of the tabatière
M. extensor carpi radialis brevis
M. abductor pollicis longus
M. extensor carpi radialis longus
M. extensor pollicis longus

408. Muscles of the right forearm,

viewed from the radial side.

M. extensor carpi radialis brevis (see also Figs. 403, 409 and 410). Form: spindle-shaped. Position: usually superficial on the radial side of the forearm, coming in contact in front with the m. extensor carpi radialis longus, behind with the m. extensor digitorum communis. Origin: epicondylus lateralis humeri, joint capsule and fascia antebrachii, fused with its neighbors. Insertion: the fibres go downward and converge, becoming attached in the middle of the forearm to a flat, long tendon which goes close behind that of the m. extensor carpi radialis longus through the second compartment of the lig. carpi dorsale (see p. 334) to the proc. styloideus oss. metacarpalis III; there, between the tendon and the bone, lies the ***bursa m. extensoris carpi radialis brevis*** (see Fig. 411), rarely absent. The tendon is crossed over by the same muscles as is that of the m. extensor carpi radialis longus (see also Fig. 412). Action: it extends the hand and abducts it. Innervation: ramus profundus n. radialis (C_6, C_7 [C_8]).

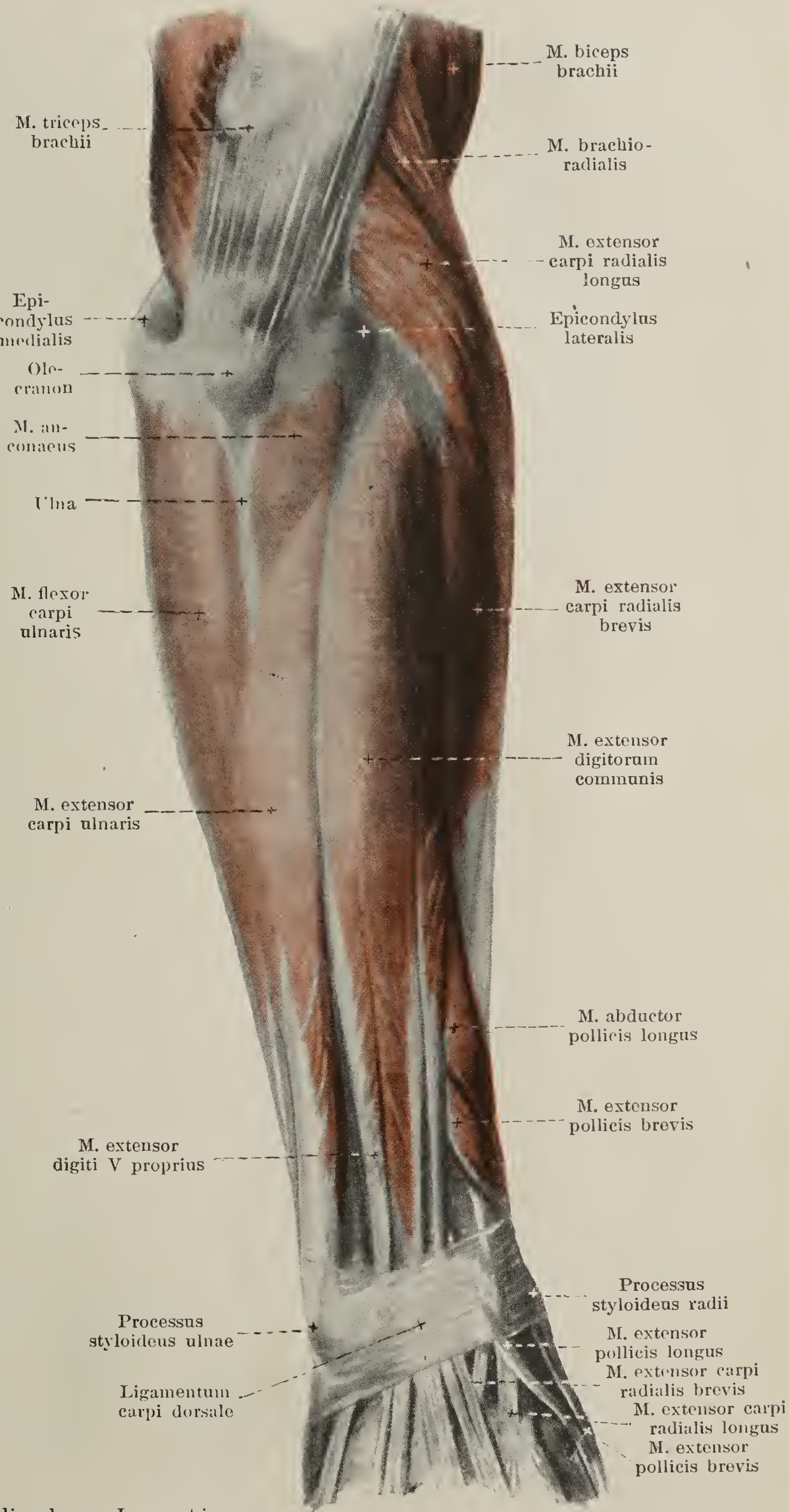
M. extensor digitorum communis (see also Figs. 409 and 412). Form: oblong-spindle-shaped. Position: superficial on the back of the forearm, radialward bounded by the m. extensor carpi radialis brevis, ulnarward by the m. extensor carpi ulnaris. Origin: epicondylus lateralis humeri, joint capsule and fascia antebrachii, fused with its neighbors. Insertion: the fibres run parallel downward and in the middle of the forearm become separated into four single bellies. Each of these goes unipinnated over into a long, flat tendon; these pass together through the fourth compartment of the lig. carpi dorsale and then diverge to go to the dorsal surface of the first phalanx of the 2nd—5th finger; each tendon sends a branch to the base of the first phalanx and each becomes attached by three processes, one in the middle going to the base of the second phalanx and two at the side converging in front and going to the base of the third. The four tendons are connected with one another upon the ossa metacarpalia by means of three oblique bands, *juncturae tendinum* (see Fig. 412), that between the 2nd and 3rd finger being weaker, or missing. Each tendon presents a triangular expansion upon the first phalanx to which become attached the mm. lumbricales and interossei (see Fig. 419). Action: it extends the hand and adducts it slightly, extends the 1st (only slightly the 2nd and 3rd) phalanx of the 2nd—5th finger; spreads the fingers apart. Innervation: ramus profundus n. radialis ([C_6] C_7, C^8).

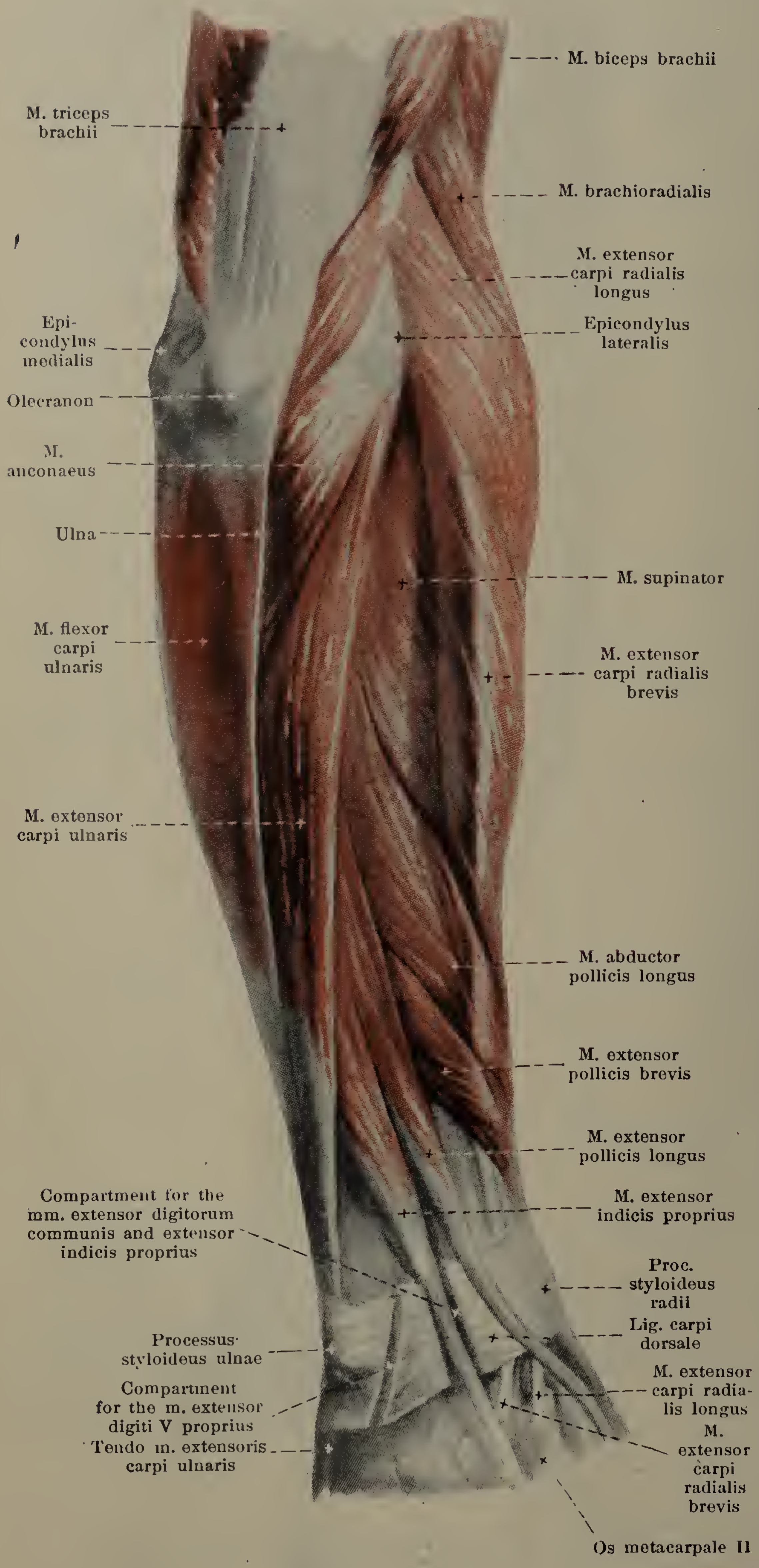
409. Muscles of the right forearm,
viewed from behind.

M. extensor digiti quinti proprius (O. T. extensor minimi digiti). Form: oblong-spindle-shaped, narrow. Position: immediately on the ulnar side of the preceding muscle, fused with it above. Origin: in common with the preceding muscle. Insertion: the long, thin tendon runs through the fifth compartment of the lig. carpi dorsale and fuses on the back of the hand with the tendon going to the little finger from the m. extensor digitorum communis (see also Fig. 412). Action: it extends the 1st phalanx of the 5th finger and removes it slightly from the 4th. Innervation: ramus profundus n. radialis (C_7, C_8).

M. anconaeus (see also Figs. 402, 408, 410 and 411). Form: flat, triangular. Position: superficial on the back of the forearm, hidden by the fascia antebrachii, above immediately adjacent to the caput mediale of the m. triceps, radialward bounded by the m. extensor carpi ulnaris, ulnarward by the ulna. Origin: by a short, strong tendon from the epicondylus lateralis humeri as well as from the lig. collaterale radiale. Insertion: the fibres diverge to the facies dorsalis ulnae. Action: it extends the forearm. Innervation: n. radialis ([C_6] **C_7**, C_8 [Th_1]).

M. extensor carpi ulnaris (see also Figs. 408, 410 and 412). Form: flat, oblong-spindle-shaped. Position: superficial on the back of the forearm, radialward bounded by the m. extensor digitorum communis resp. the m. extensor digiti V proprius, ulnarward above by the m. anconaeus, below by the ulna. Origin: epicondylus lateralis humeri, lig. collaterale radiale of the elbow joint and fascia antebrachii, fused with its neighbors; also by a thin, tendinous leaf (fused with the fascia antebrachii) from the facies dorsalis ulnae. Insertion: the fibres run ulnarward and downward to the facies dorsalis ulnae and upon this go over pinnated into a long tendon which runs through the sixth compartement of the lig. carpi dorsale, radially of the proc. styloideus ulnae (see Fig. 419), to the basis oss. metacarpalis V. Action: it adducts the hand and extends it a little. Innervation: ramus profundus n. radialis ([C_6] C_7, C_8).


M. biceps brachii
M. triceps brachii
M. brachioradialis
M. extensor carpi radialis longus
Epicondylus medialis
Epicondylus lateralis
Olecranon
M. anconaeus
Ulna
M. flexor carpi ulnaris
M. extensor carpi radialis brevis
M. extensor digitorum communis
M. extensor carpi ulnaris
M. abductor pollicis longus
M. extensor pollicis brevis
M. extensor digiti V proprius
Processus styloideus radii
Processus styloideus ulnae
M. extensor pollicis longus
M. extensor carpi radialis brevis
Ligamentum carpi dorsale
M. extensor carpi radialis longus
M. extensor pollicis brevis


M. biceps brachii
M. triceps brachii
M. brachioradialis
M. extensor carpi radialis longus
Epicondylus medialis
Epicondylus lateralis
Olecranon
M. anconaeus
Ulna
M. supinator
M. flexor carpi ulnaris
M. extensor carpi radialis brevis
M. extensor carpi ulnaris
M. abductor pollicis longus
M. extensor pollicis brevis
M. extensor pollicis longus
Compartment for the mm. extensor digitorum communis and extensor indicis proprius
M. extensor indicis proprius
Proc. styloideus radii
Processus styloideus ulnae
Lig. carpi dorsale
Compartment for the m. extensor digiti V proprius
M. extensor carpi radialis longus
Tendo m. extensoris carpi ulnaris
M. extensor carpi radialis brevis
Os metacarpale II

410. Muscles of the right forearm,

viewed from behind.

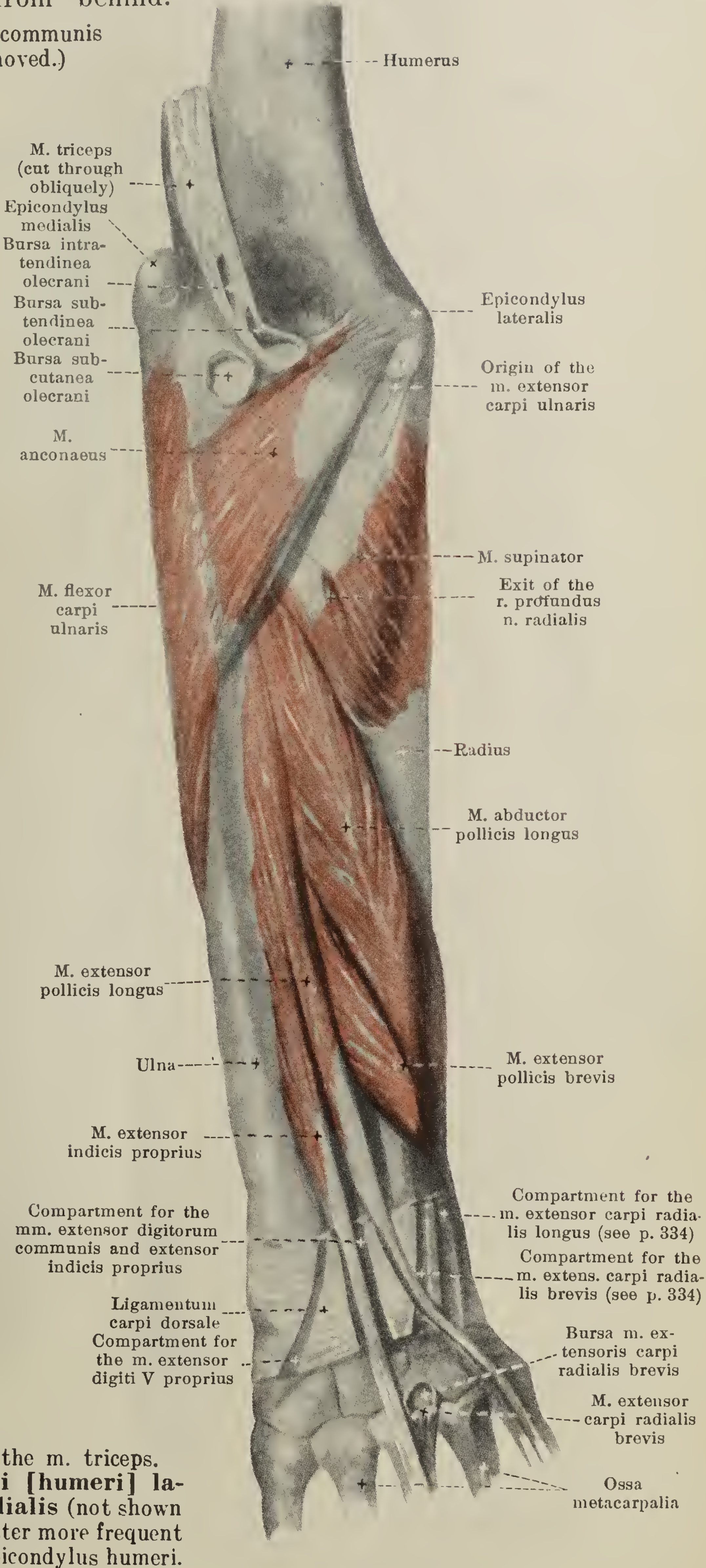
(The m. extensor digitorum communis has been removed.)

M. abductor pollicis longus (O. T. extensor ossis metacarpi pollicis) (see also Figs. 403, 408, 409, 411, 412 and 414). Form: flat, spindle-shaped, bipinnated. Position: on the posterior and radial side of the forearm; behind immediately upon the membrana interossea and the radius, covered by the mm. extensor carpi ulnaris and extensor digitorum communis, bordering proximally on the m. supinator, distally on mm. extensores pollicis; radialward superficially, passing over the mm. extensores carpi radiales. Origin: facies dorsalis ulnae, membrana interossea and facies dorsalis radii. Insertion: the fibres converge radialward and downward to form a flat tendon, which, at the radial side of the forearm, goes between the mm. extensores carpi radiales and flexor carpi radialis through the first compartment of the lig. carpi dorsale, partly to the m. abductor pollicis brevis, partly to the basis oss. metacarpalis I. Action: it supinates slightly the forearm; it flexes the hand slightly volarward and abducts it; it abducts the thumb and draws it dorsalward. Innervation: ramus profundus n. radialis ([C_6] C_7, C_8).

M. extensor pollicis brevis (O. T. extensor primi internodii pollicis) (see also Figs. 406, 408, 409, 411 and 412). Form: spindle-shaped. Position: just distalward from the preceding muscle. Origin: membrana interossea and facies dorsalis radii. Insertion: it runs exactly as does the preceding muscle (often inseparably fused with it) and, close to it, goes upon the back of the os metacarpale I to the base of the first phalanx of the thumb. Action: it supinates slightly the forearm; flexes the hand a trifle volarward and abducts it; it abducts the thumb and draws it dorsalward; it extends the first phalanx of the same. Innervation: ramus profundus n. radialis ([C_6] C_7, C_8).

411. Muscles of the right forearm (deep layer), viewed from behind.

(The mm. extensores carpi, digitorum communis and digiti V proprius have been removed.)


Humerus
M. triceps (cut through obliquely)
Epicondylus medialis
Bursa intratendinea olecrani
Bursa subtendinea olecrani
Bursa subcutanea olecrani
Epicondylus lateralis
Origin of the m. extensor carpi ulnaris
M. anconaeus
M. supinator
Exit of the r. profundus n. radialis
M. flexor carpi ulnaris
Radius
M. abductor pollicis longus
M. extensor pollicis longus
Ulna
M. extensor pollicis brevis
M. extensor indicis proprius
Compartment for the m. extensor carpi radialis longus (see p. 334)
Compartment for the mm. extensor digitorum communis and extensor indicis proprius
Compartment for the m. extens. carpi radialis brevis (see p. 334)
Ligamentum carpi dorsale
Compartment for the m. extensor digiti V proprius
Bursa m. extensoris carpi radialis brevis
M. extensor carpi radialis brevis
Ossa metacarpalia

M. extensor pollicis longus (O. T. extensor secundi internodii pollicis) (see also Figs. 408—410 and 412). Form: long-spindle-shaped, pinnated. Position: ulnarward from and dorsally to the two preceding muscles, immediately upon the ulna and radius, covered by the same muscles as are they. Origin: facies dorsalis ulnae and membrana interossea. Insertion: the fibres go over into a long tendon, which passes obliquely or in a bow (around a ridge of the radius) behind the tendons of the mm. extensores carpi radiales through the third compartment of the lig. carpi dorsale and then to the base of the second phalanx of the thumb. Action: it supinates the forearm slightly; it extends the hand and abducts it; it draws the thumb dorsalward and adducts the same; it extends its phalanges. Innervation: ramus profundus n. radialis ($[C_6]$ C_7, C_8).

M. extensor indicis proprius (O. T. extensor indicis) (see also Fig. 410). Form: oblong-spindle-shaped. Position: ulnarward from and dorsally to the preceding muscle, immediately upon the ulna, covered by the mm. extensor carpi ulnaris, extensor digiti V proprius and extensor digitorum communis. Origin: facies dorsalis ulnae and membrana interossea. Insertion: the fibres converge to form a flat tendon which goes in common with the tendons of the m. extensor digitorum communis through the fourth compartment of the lig. carpi dorsale and then fuses with the ulnar margin of the tendon of this muscle that goes to the index finger. Action: it supinates the forearm a trifle; it extends the hand and abducts it slightly; it extends the index finger and draws it ulnarward. Innervation: ramus profundus n. radialis ($[C_6]$ C_7, C_8).

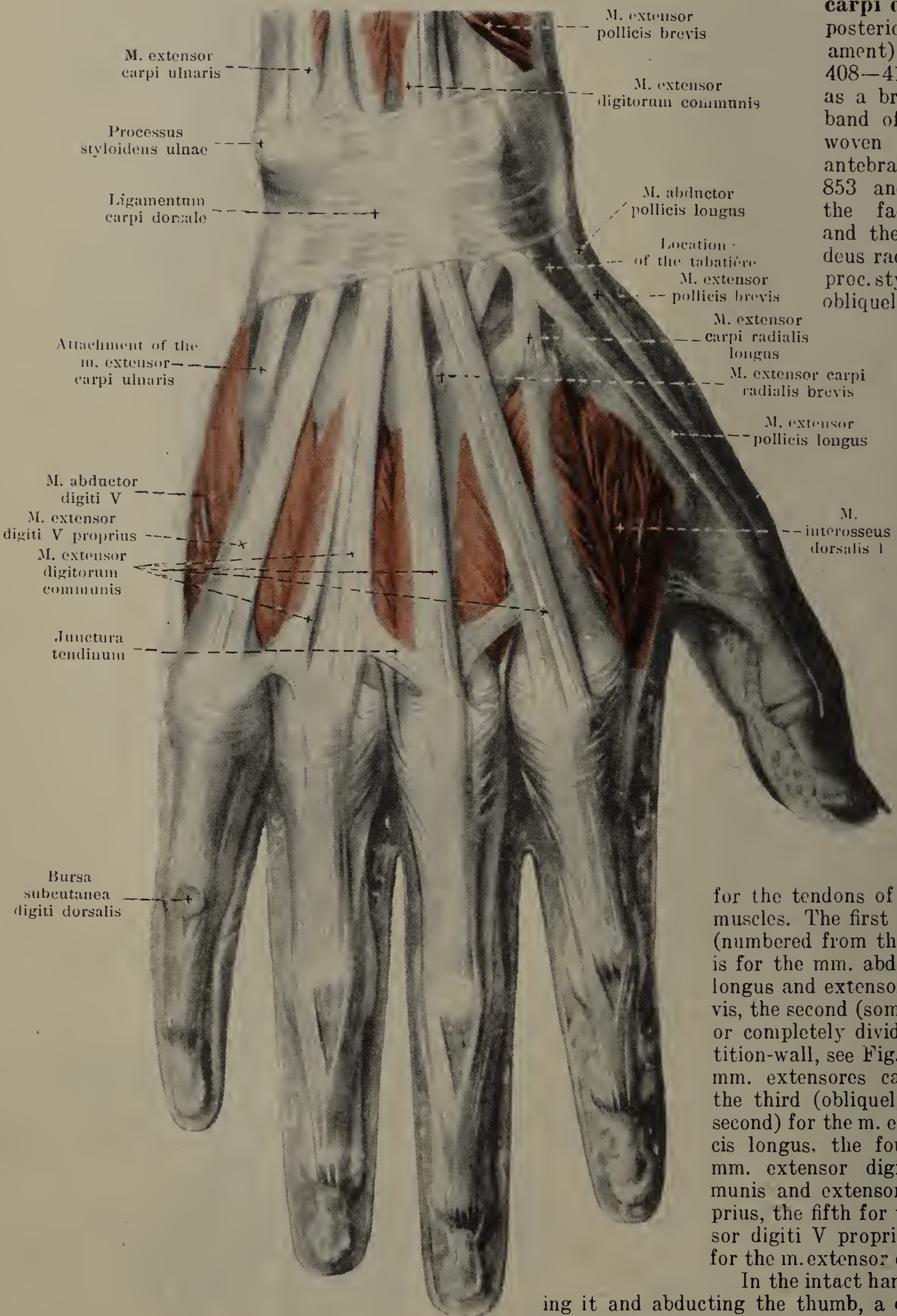
Bursa subcutanea olecrani, very frequent, upon the olecranon.

Bursa infratendinea olecrani, very frequent, in the tendon of the m. triceps.

Bursa subtendinea olecrani, occasional, in front of the tendon of the m. triceps.

Bursae subcutaneae epicondyli [humeri] lateralis et epicondyli [humeri] medialis (not shown in figure), the former occasional, the latter more frequent in the adult, upon the corresponding epicondylus humeri.

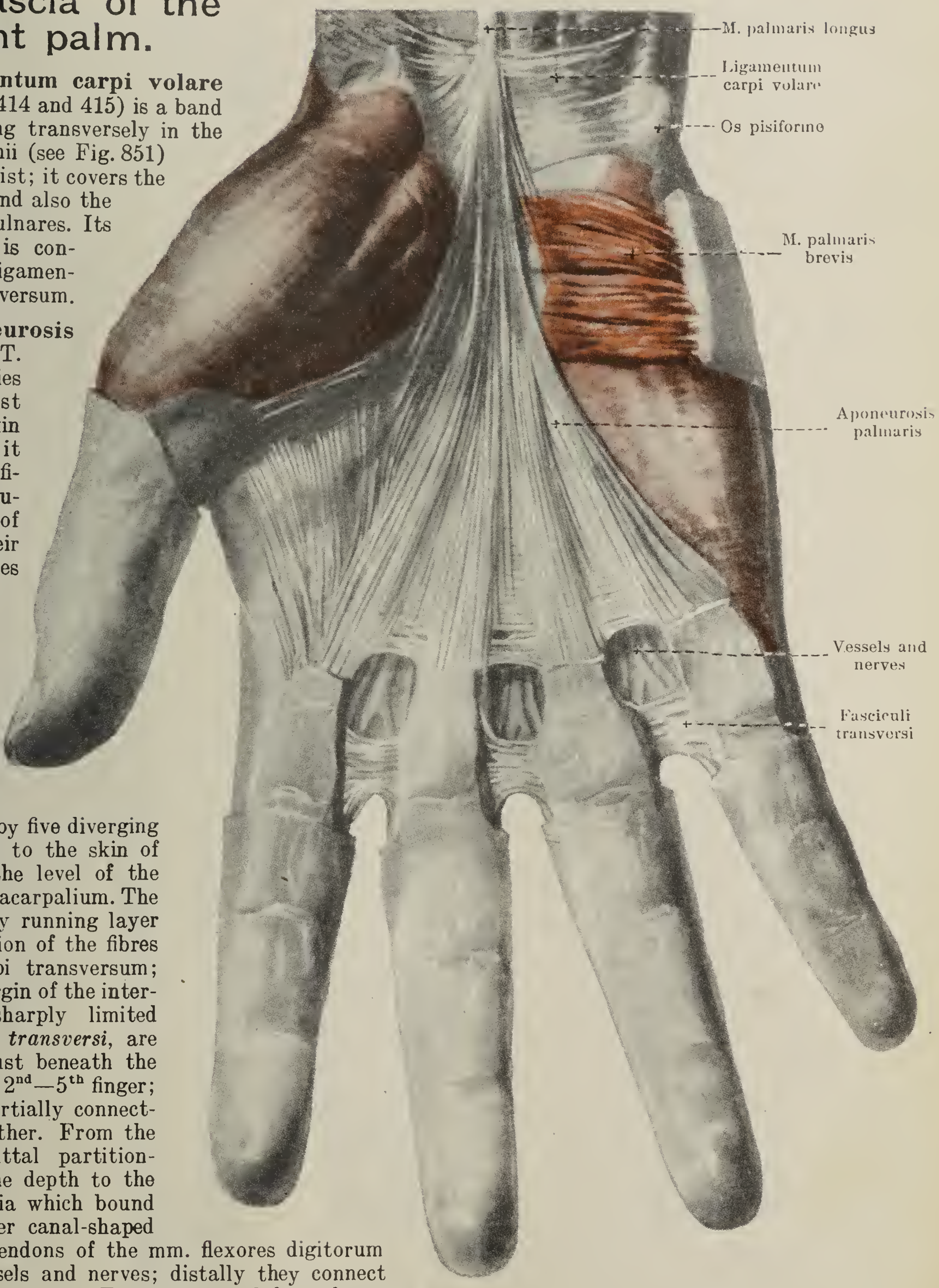
412. Back of the right hand.


M. extensor pollicis brevis
M. extensor carpi ulnaris
M. extensor digitorum communis
Processus styloideus ulnae
Ligamentum carpi dorsale
M. abductor pollicis longus
Location of the tabatière
M. extensor pollicis brevis
M. extensor carpi radialis longus
Attachment of the m. extensor carpi ulnaris
M. extensor carpi radialis brevis
M. extensor pollicis longus
M. abductor digiti V
M. extensor digiti V proprius
M. interosseus dorsalis I
M. extensor digitorum communis
Junctura tendinum
Bursa subcutanea digiti dorsalis

Ligamentum carpi dorsale (O.T. posterior annular ligament) (see also Figs. 408—411) extends as a broad, powerful band of fibres, interwoven in the fascia antebrachii (see Figs. 853 and 860), from the facies lateralis and the proc. styloideus radii, behind the proc. styloideus ulnae, obliquely distalward to the os triquetrum and os pisiforme. It is connected by strong processes with the posterior surface of the radius, and proximally joining fibre bundles fix the m. extensor carpi ulnaris on the ulna; in this way six cylindrical compartments are formed for the tendons of the extensor muscles. The first compartment (numbered from the radial side) is for the mm. abductor pollicis longus and extensor pollicis brevis, the second (sometimes partly or completely divided by a partition-wall, see Fig. 411) for the mm. extensores carpi radiales, the third (obliquely behind the second) for the m. extensor pollicis longus, the fourth for the mm. extensor digitorum communis and extensor indicis proprius, the fifth for the m. extensor digiti V proprius, the sixth for the m. extensor carpi ulnaris.

In the intact hand on extending it and abducting the thumb, a depression or groove is seen distally to the processus styloideus and lying between the ridges formed ventrally by mm. abductor pollicis longus and extensor pollicis brevis, and dorsally by the m. extensor pollicis longus; this is known as the *tabatière* (see also Fig. 408).

413. Fascia of the right palm.

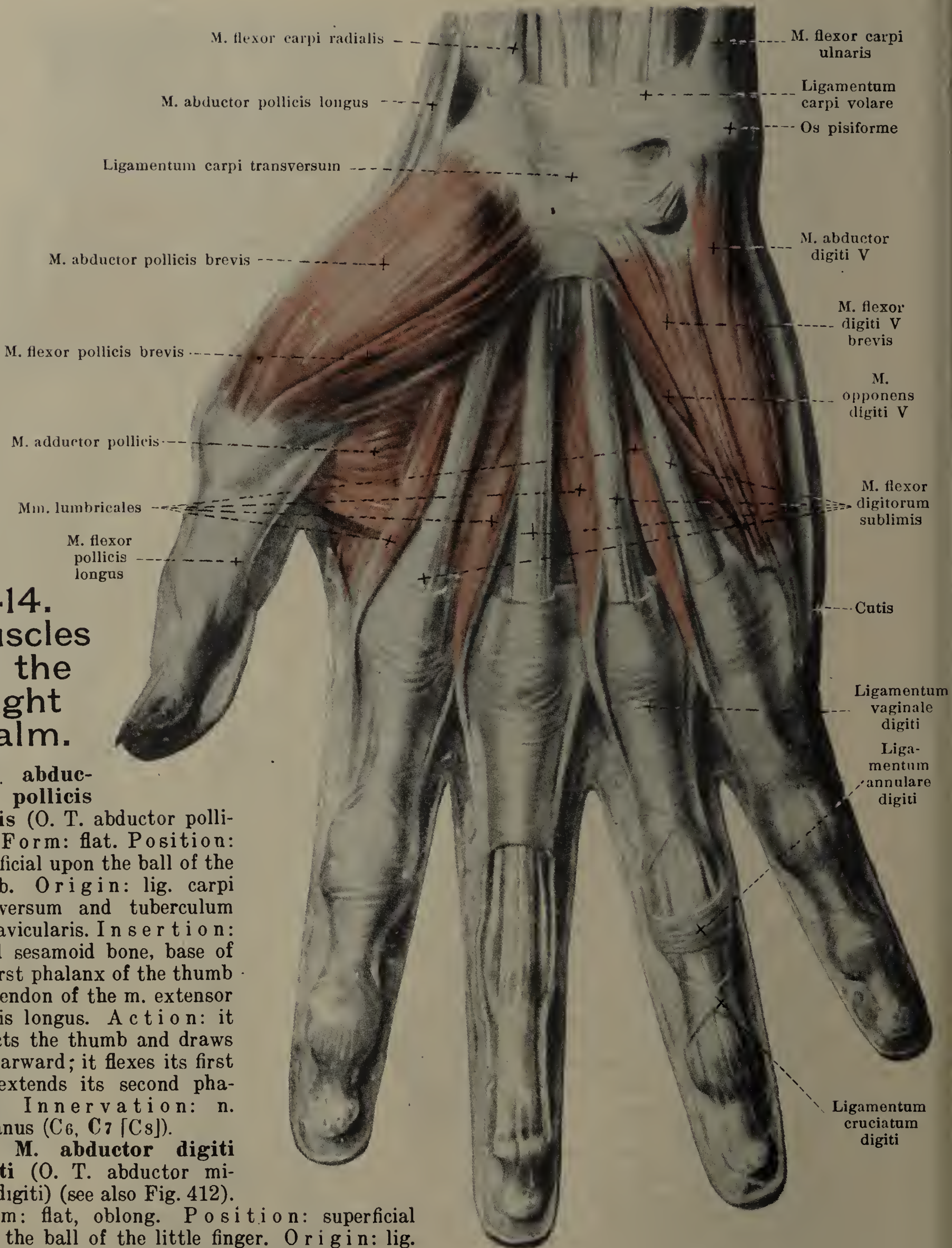


The **ligamentum carpi volare** (see also Figs. 414 and 415) is a band of fibres running transversely in the fascia antebrachii (see Fig. 851) just over the wrist; it covers the flexor muscles and also the a., vv., and n. ulnares. Its radial portion is connected with the ligamentum carpi transversum.

The **aponeurosis palmaris** (O. T. palmar fascia) lies in the palm just beneath the skin connected with it firmly by short fibres. It is triangular and consists of two layers. Their superficial fibres running longitudinally are the continuation of the tendon of the m. palmaris longus (when it is absent they begin before the lig. carpi transversum) and go by five diverging processes partly to the skin of the fingers at the level of the capitula oss. metacarpalium. The deep transversely running layer is the continuation of the fibres of the lig. carpi transversum; near the free margin of the interdigital folds sharply limited bands, *fasciculi transversi*, are stretched out just beneath the skin between the 2nd—5th finger; they are also partially connected with one another. From the deep layer sagittal partition-walls go into the depth to the ossa metacarpalia which bound one from another canal-shaped spaces for the tendons of the mm. flexores digitorum and for the vessels and nerves; distally they connect with the ligg. vaginalia. The *thenar* and *hypothenar* eminences are covered only by thin fascia. Upon the hypothenar eminence there lies in addition the

M. palmaris brevis, flat, quadrangular. Origin: ulnar margin of the aponeurosis palmaris. Insertion: to the skin at the ulnar margin of the hand. Action: it wrinkles the skin, and deepens the hollow of the hand. Innervation: ramus superficialis of the ramus volaris manus n. ulnaris ($[C_7]$ C_8 $[Th_1]$).

Lig. carpi transversum (O. T. anterior annular ligament) (see also Figs. 414—416) is a tough fibrous band which extends transversely between the eminentiae carpi and the adjacent ligaments; it bridges over the sulcus carpi (see p. 119) and sends out on the ulnar side of the tendon of the m. flexor carpi radialis, tendinous branches deeply to the ossa multangula and capitatum, so that there is a separate canal formed for this tendon.

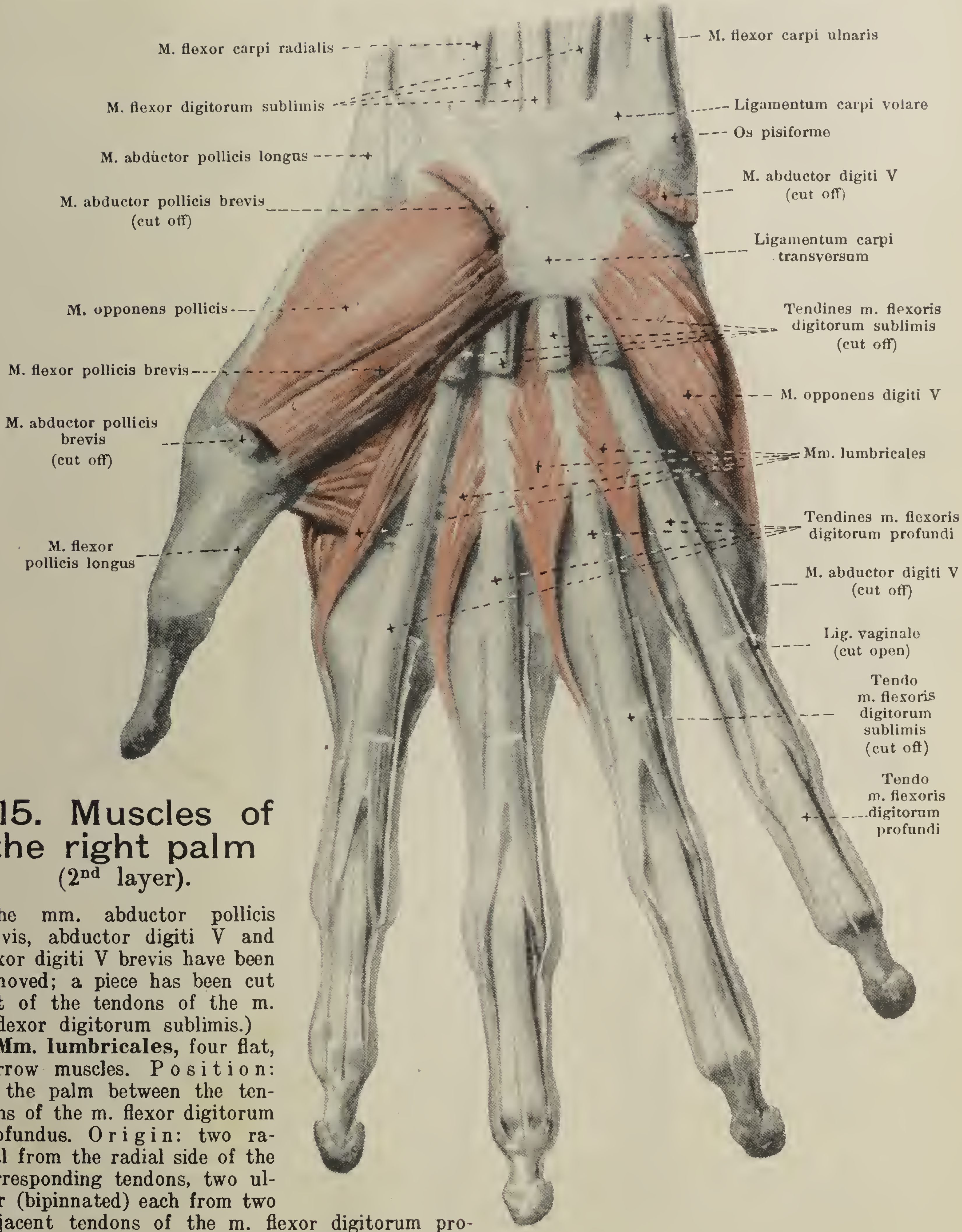

M. flexor carpi radialis
M. abductor pollicis longus
Ligamentum carpi transversum
M. abductor pollicis brevis
M. flexor pollicis brevis
M. adductor pollicis
Mm. lumbricales
M. flexor pollicis longus
M. flexor carpi ulnaris
Ligamentum carpi volare
Os pisiforme
M. abductor digiti V
M. flexor digiti V brevis
M. opponens digiti V
M. flexor digitorum sublimis
Cutis
Ligamentum vaginale digiti
Ligamentum annulare digiti
Ligamentum cruciatum digiti

414. Muscles of the right palm.

M. abductor pollicis brevis (O. T. abductor pollicis). Form: flat. Position: superficial upon the ball of the thumb. Origin: lig. carpi transversum and tuberculum oss. navicularis. Insertion: radial sesamoid bone, base of the first phalanx of the thumb and tendon of the m. extensor pollicis longus. Action: it abducts the thumb and draws it volarward; it flexes its first and extends its second phalanx. Innervation: n. medianus (C_6, C_7 [C_8]).

M. abductor digiti quinti (O. T. abductor minimi digiti) (see also Fig. 412). Form: flat, oblong. Position: superficial upon the ball of the little finger. Origin: lig. carpi transversum and os pisiforme. Insertion: base of the first phalanx of the 5th finger and to its extensor tendons. Action: it draws the 5th finger volarward and abducts it; it flexes its 1st and extends its 2nd and 3rd phalanx. Innervation: ramus profundus of the ramus volaris manus n. ulnaris ([C_7] C_8 [Th_1]).

M. flexor digiti quinti brevis (O. T. flexor brevis minimi digiti), frequently absent. Form: flat, oblong. Position: superficial, on the radial side of the preceding muscle. Orig.: lig. carpi transversum and hamulus oss. hamati. Insertion: base of the first phalanx of the 5th finger. Action: it flexes the first phalanx of the little finger. Innervat.: like that of the preceding muscle.


M. flexor carpi radialis
M. flexor digitorum sublimis
M. abductor pollicis longus
M. abductor pollicis brevis (cut off)
M. opponens pollicis
M. flexor pollicis brevis
M. abductor pollicis brevis (cut off)
M. flexor pollicis longus
M. flexor carpi ulnaris
Ligamentum carpi volare
Os pisiforme
M. abductor digiti V (cut off)
Ligamentum carpi transversum
Tendines m. flexoris digitorum sublimis (cut off)
M. opponens digiti V
Mm. lumbricales
Tendines m. flexoris digitorum profundi
M. abductor digiti V (cut off)
Lig. vaginale (cut open)
Tendo m. flexoris digitorum sublimis (cut off)
Tendo m. flexoris digitorum profundi

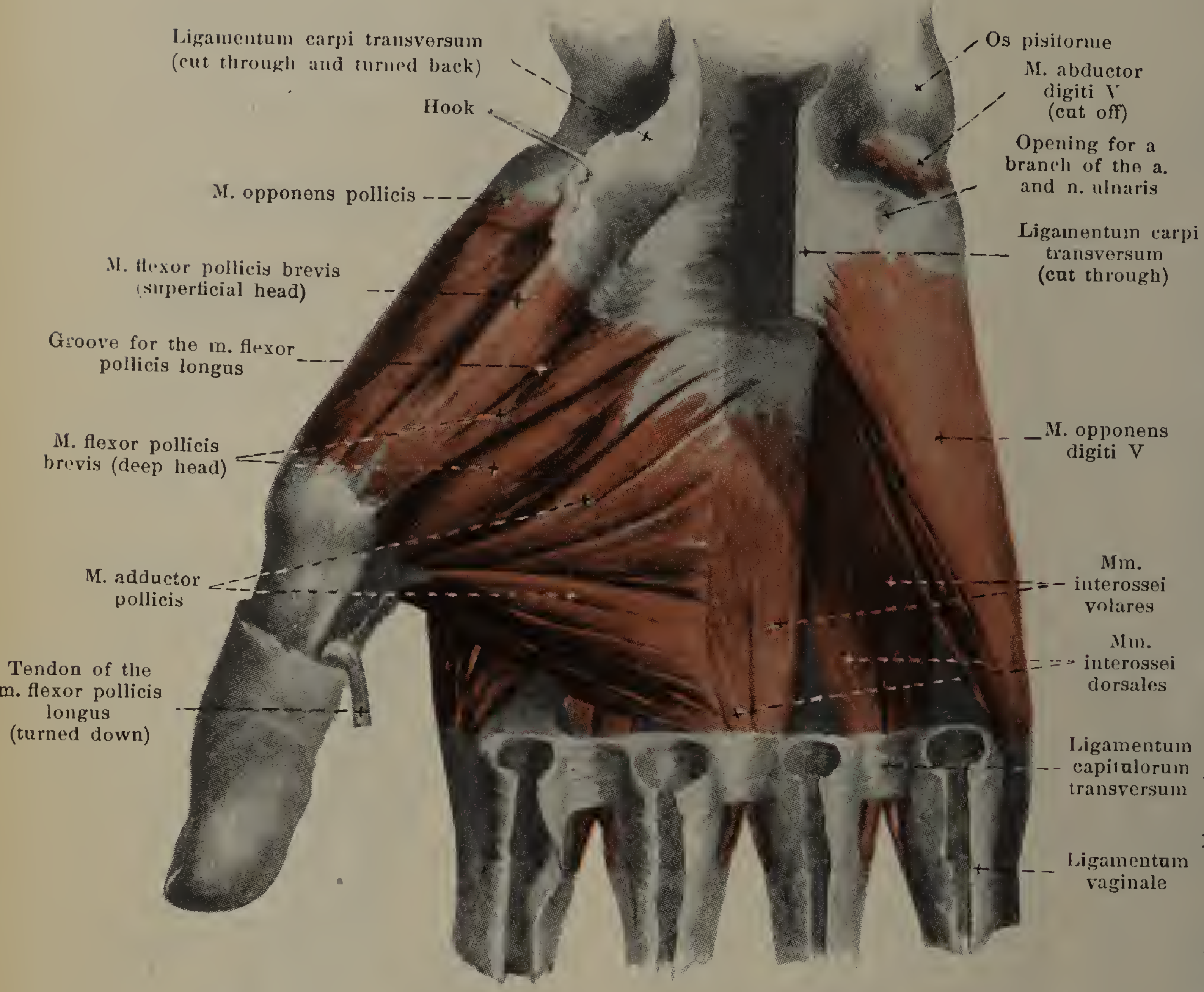
415. Muscles of the right palm (2nd layer).

(The mm. abductor pollicis brevis, abductor digiti V and flexor digiti V brevis have been removed; a piece has been cut out of the tendons of the m. flexor digitorum sublimis.)

Mm. lumbricales, four flat, narrow muscles. Position: in the palm between the tendons of the m. flexor digitorum profundus. Origin: two radial from the radial side of the corresponding tendons, two ulnar (bipinnated) each from two adjacent tendons of the m. flexor digitorum profundus. Insertion: the fibres converge to form narrow tendons which run, volarward from the lig. capitulorum transversum (see Fig. 292), to the posterior surface of the first phalanx and to the triangular expansions of the tendons of the m. extensor digitorum communis (see Fig. 412). The 1st, 2nd and 4th m. lumbricalis goes to the radial side of the 2nd, 3rd and 5th finger. The 3rd either runs to the radial side of the 4th finger, or forkes and goes to the radial side of the 4th and to the ulnar side of the 3rd finger; both kinds of insertion are equally frequent. Action: they flex the first and extend the second and third phalanx of the 2nd—5th finger. Innervation: 2(—3) radial from the n. medianus, 2(—1) ulnar from the ramus profundus of the ramus volaris manus n. ulnaris, the 3rd often from both (C_7, C_8, Th_1).

416. Deep muscles of the ball of the right thumb.

(The long flexor muscles and the superficial muscles of both eminences have been removed.)

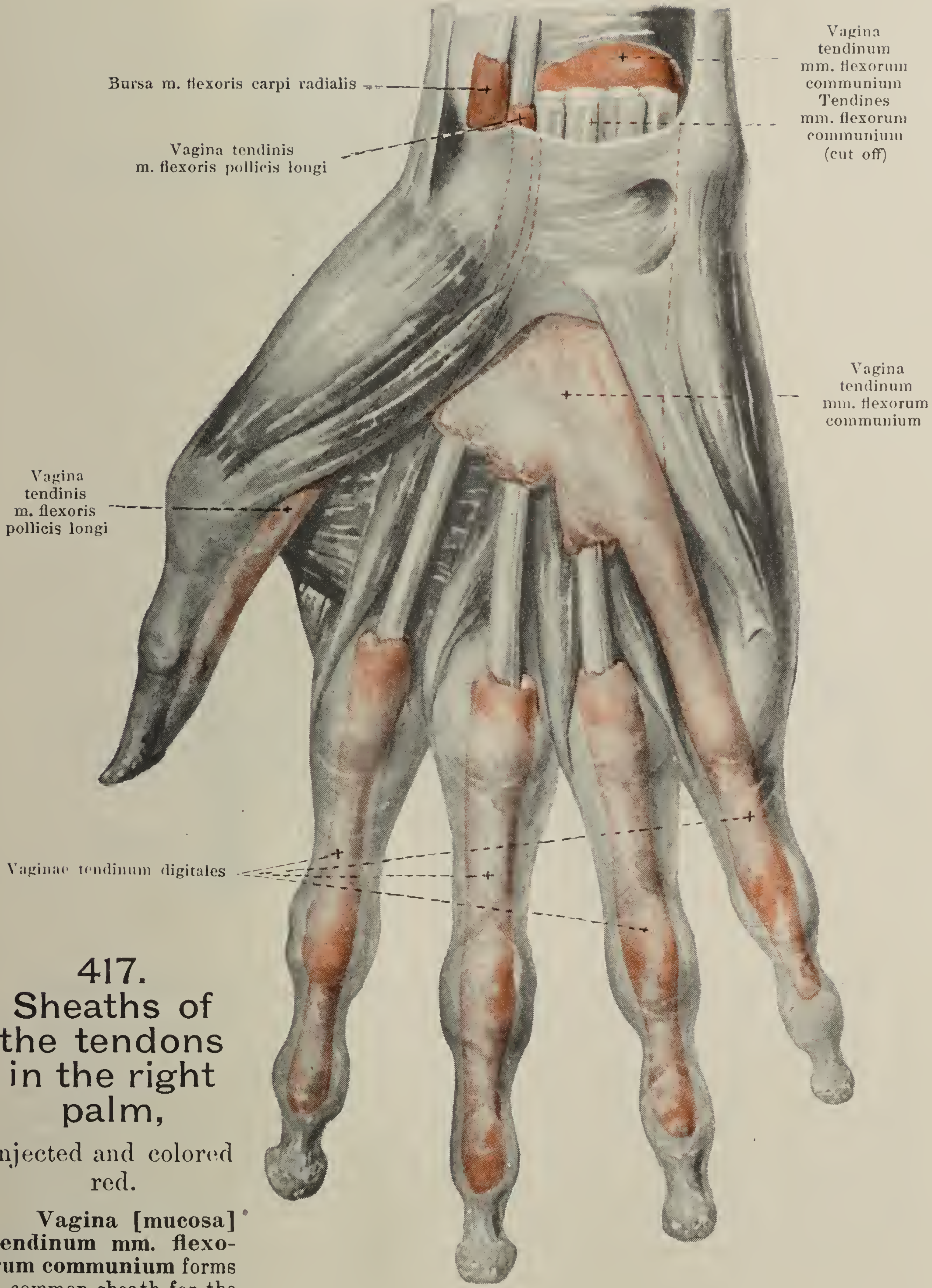

Ligamentum carpi transversum (cut through and turned back)
Hook
M. opponens pollicis
M. flexor pollicis brevis (superficial head)
Groove for the m. flexor pollicis longus
M. flexor pollicis brevis (deep head)
M. adductor pollicis
Tendon of the m. flexor pollicis longus (turned down)
Os pisiforme
M. abductor digiti V (cut off)
Opening for a branch of the a. and n. ulnaris
Ligamentum carpi transversum (cut through)
M. opponens digiti V
Mm. interossei volares
Mm. interossei dorsales
Ligamentum capitulorum transversum
Ligamentum vaginale

M. opponens pollicis (see also Fig. 415). Form: flat, oblong-quadrangular. Position: in the ball of the thumb, covered by the m. abductor pollicis brevis. Origin: ligam. carpi transversum and tuberculum ossis multanguli majoris. Insertion: corpus and capitulum ossis metacarpalis I. Action: it adducts the thumb and draws it volarward. Innervation: n. medianus (C_6, C_7 [C_8, Th_1]).

M. flexor pollicis brevis (see also Figs. 414 and 415). Form: oblong-quadrangular. Position: ulnar margin of the ball of the thumb and in the depth; bounded radialward by the m. opponens pollicis, ulnarward by the m. adductor pollicis. Origin: by two heads; *superficial head:* lig. carpi transversum; *deep head:* ossa multangula, capitatum, metacarpale II. Insertion: *superficial head* to the radial sesamoid bone, *deep head* by two divisions (one narrower, radial and ohne thicker, ulnar) to the radial and ulnar sesamoid bones, both heads also to the base of the first phalanx of the thumb and partly to the tendon of the m. extensor pollicis longus. Between the two heads and upon the radial compartment of the deep head is a groove for the tendon of the m. flexor pollicis longus. Action: it draws the thumb volarward; bundle of fibres to the radial sesamoid bone abduct, those to the ulnar sesamoid bone adduct the thumb; it flexes the first and extends the second phalanx of the thumb. Innervation: superficial portions by the n. medianus, deep by the ramus profundus of the ramus volaris manus n. ulnaris (C_6, C_7, C_8).

M. adductor pollicis (see also Figs. 414 and 415). Form: flat, triangular. Position in the depth of the palm, immediately upon the bones and the mm. interossei; covered by the tendons of the mm. flexores digitorum, being bounded radialward by the preceding muscle, and frequently fused with it. Origin: os metacarpale III. Insertion: ulnar sesamoid bone, base of the first phalanx of the thumb and tendon of the m. extensor pollicis longus. Action: it adducts the thumb and draws it volarward; it flexes the first and extends the second phalanx of the thumb. Innervation: ramus profundus of the ramus volaris manus n. ulnaris (C_7, C_8, Th_1).

M. opponens digiti quinti (O. T. opponens minimi digiti) (see also Figs. 414 and 415). Form. flat, oblong-quadrangular. Position: in the ball of the little finger, almost completely covered by the mm. abductor and flexor digiti V brevis. Origin: lig. carpi transversum and hamulus oss. hamati, pierced by an opening for the rami profundi a. ulnaris and rami volaris manus n. ulnaris. Insertion: corpus and capitulum oss. metacarpalis V. Action: it draws the fifth finger volarward. Innervation: ramus profundus of the ramus volaris manus n. ulnaris ([C_7] C_8 [Th_1]).

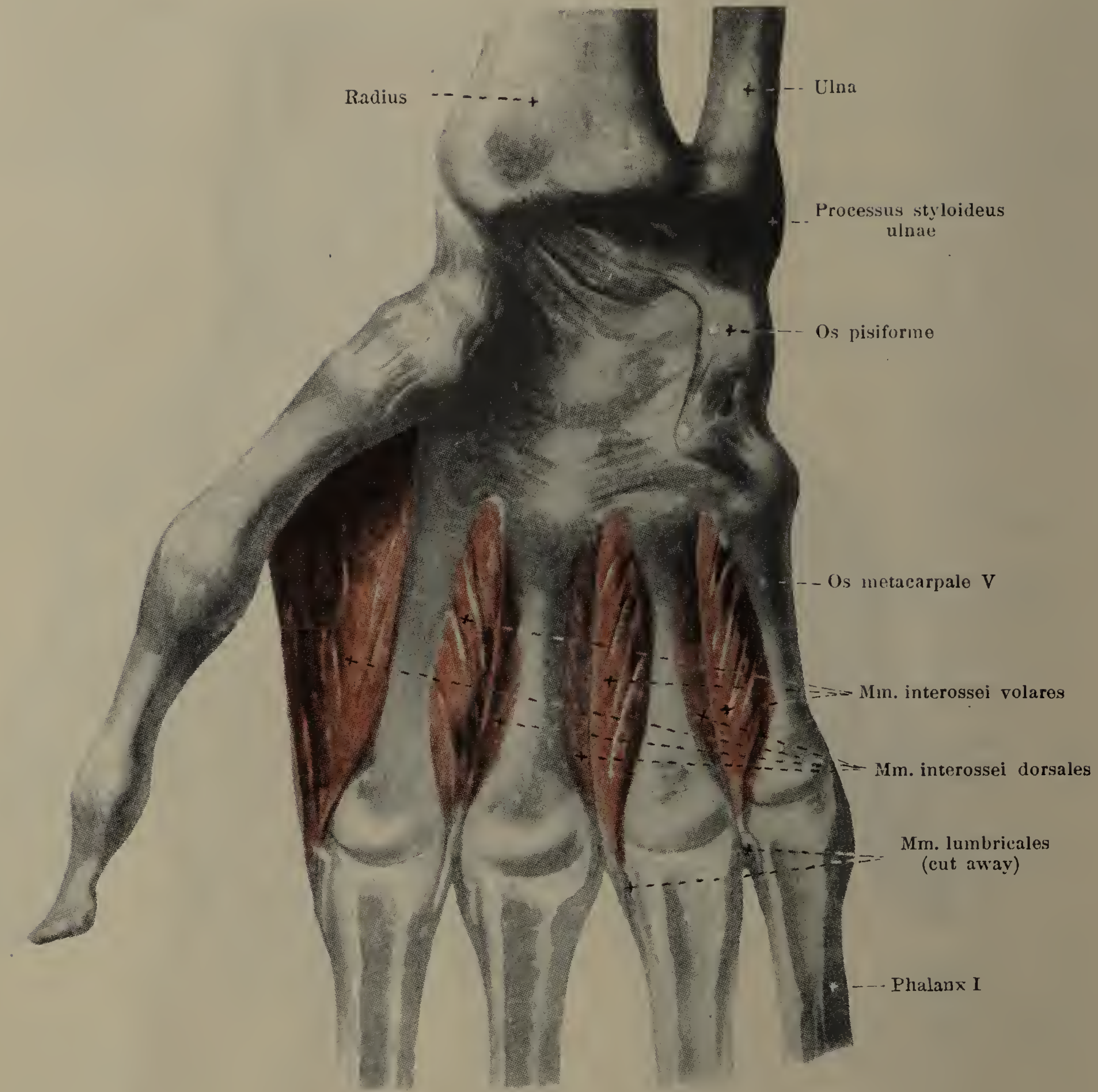

Bursa m. flexoris carpi radialis
Vagina tendinis m. flexoris pollicis longi
Vagina tendinum mm. flexorum communium
Tendines mm. flexorum communium (cut off)
Vagina tendinum mm. flexorum communium
Vagina tendinis m. flexoris pollicis longi
Vaginae tendinum digitales

417. Sheaths of the tendons in the right palm,

injected and colored red.

Vagina [mucosa] tendinum mm. flexorum communium forms a common sheath for the tendons of the mm. flexores digitorum communes; it begins a little above the lig. carpi transversum and ends in the middle of the palm; very often a special sheath entirely or partially separated from the main sheath is to be found, radialward, for the tendons of the index finger (see also p. 340).

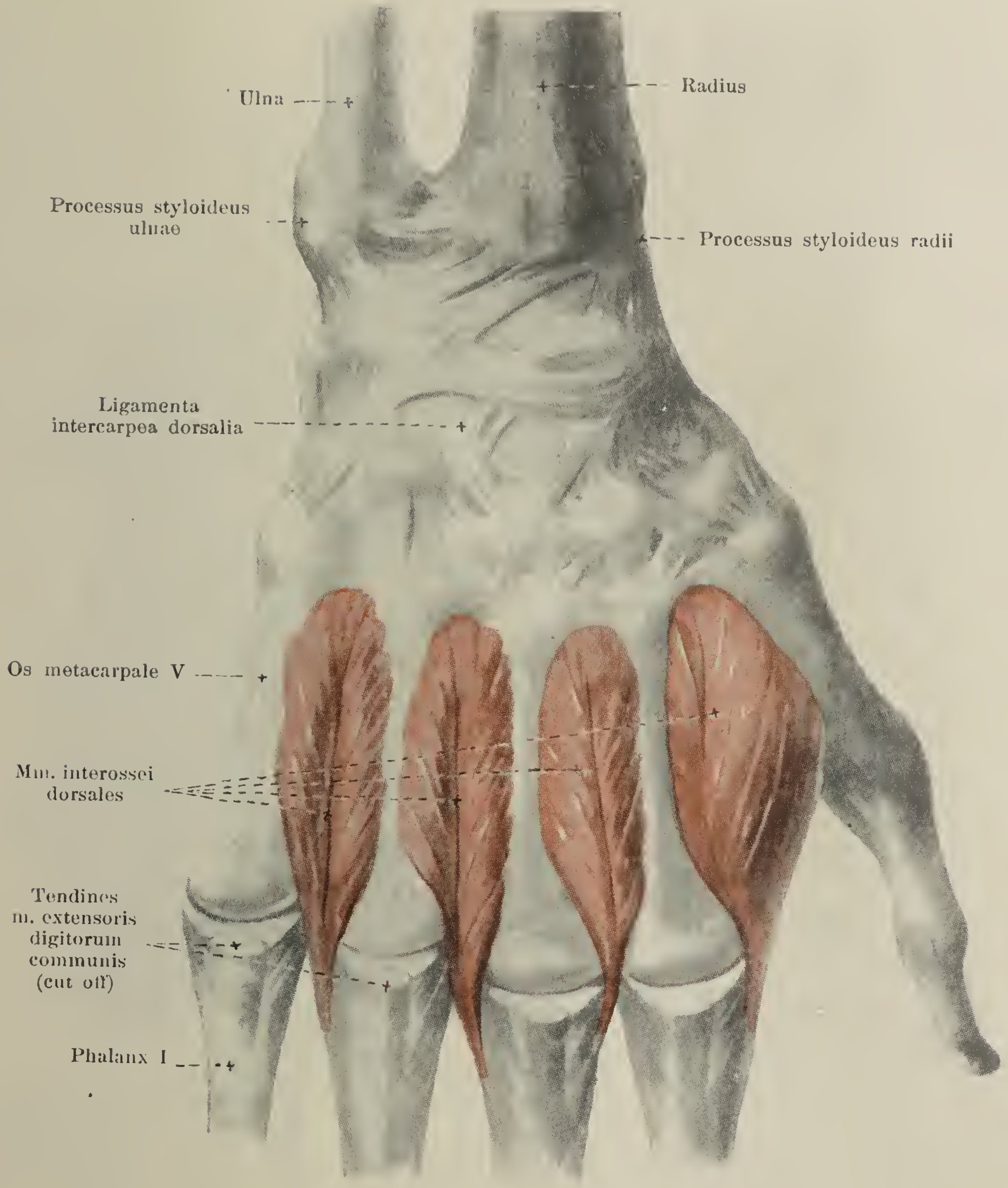
Vagina tendinis m. flexoris pollicis longi accompanies the tendon of the m. flexor pollicis longus from the upper margin of the lig. carpi transversum as far as the second phalanx; it communicates with the preceding sheath in half the cases.



418. Mm. interossei volares manus dextrae.

The **vaginae tendinum digitales** (see Fig. 417) are four long sheaths, which on the volar surface of the 2nd—5th finger from the region of the capitulum oss. metacarpalis on, surround the tendons of the mm. flexores digitorum communes in common as far as the third phalanx; that of the 5th finger is connected in the adult very often with the vagina tendinum mm. flexorum communium. The tendons are bridged over in the region of each of these tendinous sheaths, in certain places, by powerful horse-shoe-shaped connective tissue bands, *ligamenta vaginalia*, attached beside them on both sides to the bone (see p. 208), and are thereby prevented from coming away from the underlayer; the bands run, partly transversely (on the level of the joints), partly obliquely or crossed (between the joints), *ligamenta annularia* and *ligamenta cruciata manus digitorum* (see Fig. 414).

Mm. interossei volares (O. T. palmar interossei), three flat, triangular, small muscles. Position: in the depth of the palm, in the interspaces between the ossa metacarpalia II—V, covered by all the other muscles of the palm. Origin: on the lateral surfaces of the ossa metacarpalia — the first on the ulnar surface of the 2nd finger, the second and third on the radial surfaces of the 4th and 5th (see also Fig. 184). Insertion: each of the narrow tendons goes dorsalward from the lig. capitulorum transversum (see Fig. 292) on the same side of the finger to the back of the first phalanx and to the triangular expansion of the corresponding tendon of the m. extensor digitorum communis (see Fig. 412). Action: they draw the first phalanx of the 2nd, 4th and 5th finger toward the middle finger, flex the first phalanx and extend the second and third phalanx of the 2nd, 4th and 5th finger. Innervation: ramus profundus of the ramus volaris manus n. ulnaris ([C_7] C_8, Th_1).

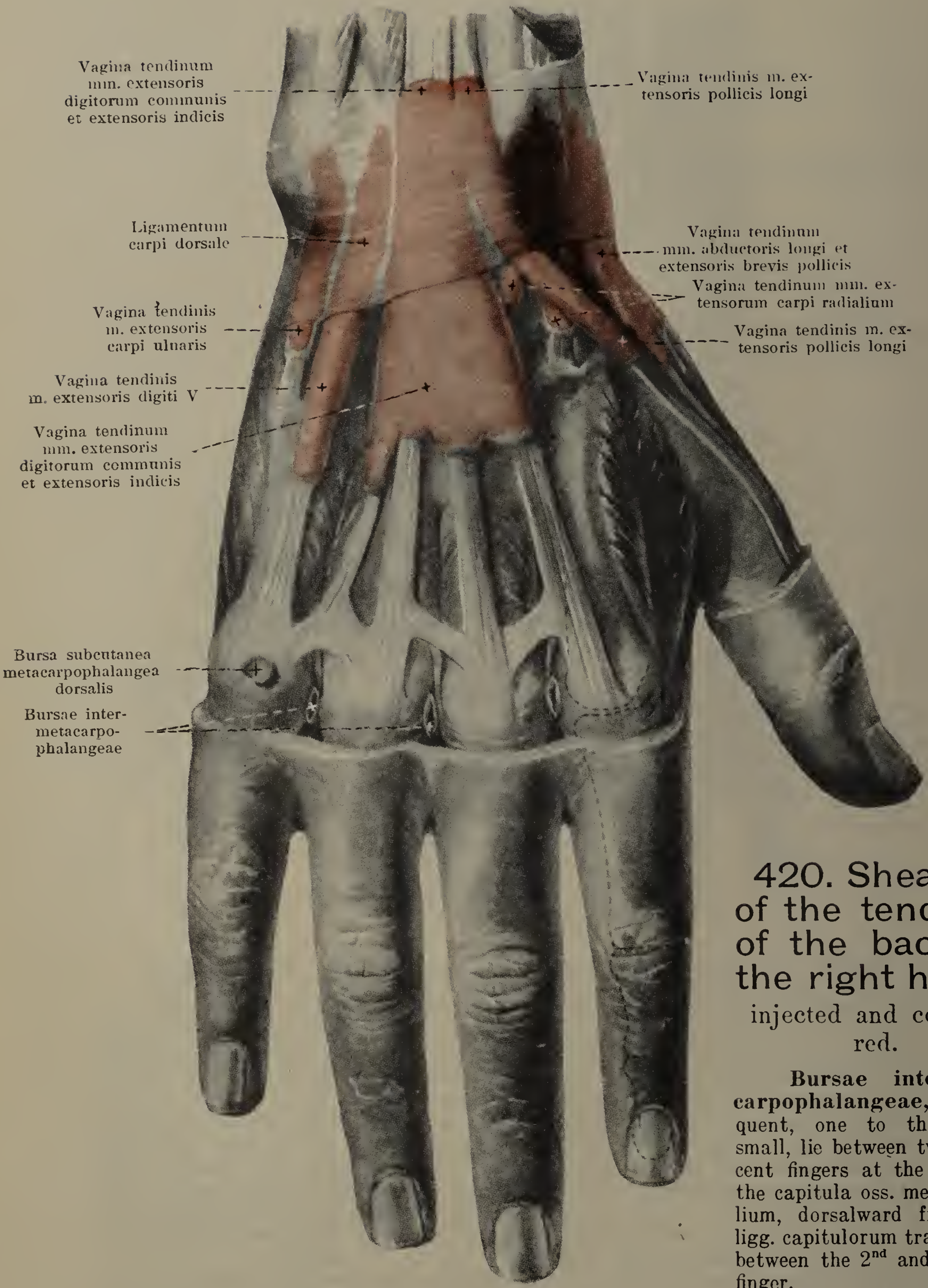

Ulna
Radius
Processus styloideus ulnae
Processus styloideus radii
Ligamenta intercarpea dorsalia
Os metacarpale V
Mm. interossei dorsales
Tendines m. extensoris digitorum communis (cut off)
Phalanx I

419. Mm. interossei dorsales manus dextrae.

Mm. interossei dorsales (see also Figs. 412 and 418), four flat, triangular, bipinnate, small muscles. Position: in the interspaces between the ossa metacarpalia, nearer the back of the hand. Origin: each comes from the neighboring surfaces of the ossa metacarpalia (see also Fig. 185). Insertion: each of the narrow tendons runs dorsalward from the lig. capitulorum transversum (see Fig. 292) — the first and second each on the radial side of the 2nd and 3rd finger, the third and fourth each on the ulnar side of the 3rd and 4th finger, to the back of the first phalanx and to the triangular expansion of the corresponding tendon of the m. extensor digitorum communis (see also Fig. 412). Action: the first adducts the thumb; the first and second draw the 1st phalanx of the 2nd and 3rd finger radialward, the third and fourth draw that of the 3rd and 4th finger ulnarward; all flex the first phalanx and extend the second and third phalanx of the 2nd—4th finger. Innervation: ramus profundus of the ramus volaris manus n. ulnaris ([C_7] C_8, Th_1).

Vagina tendinum mm. abductoris longi et extensoris brevis pollicis, vagina tendinum mm. extensorum carpi radialium (at the newborn one for each tendon), **vagina tendinis m. extensoris pollicis longi** (communicating constantly with the preceding), **vagina tendinis m. extensoris digiti quinti** and **vagina tendinis m. extensoris carpi ulnaris** (see Fig. 420) surround their corresponding tendons at the lig. carpi dorsale and for varying distances distal to it.

Vagina tendinum mm. extensoris digitorum communis et extensoris indicis (see Fig. 420) forms a sheath for the tendons of these muscles in common from the proximal margin of the lig. carpi dorsale as far as the middle of the ossa metacarpalia.

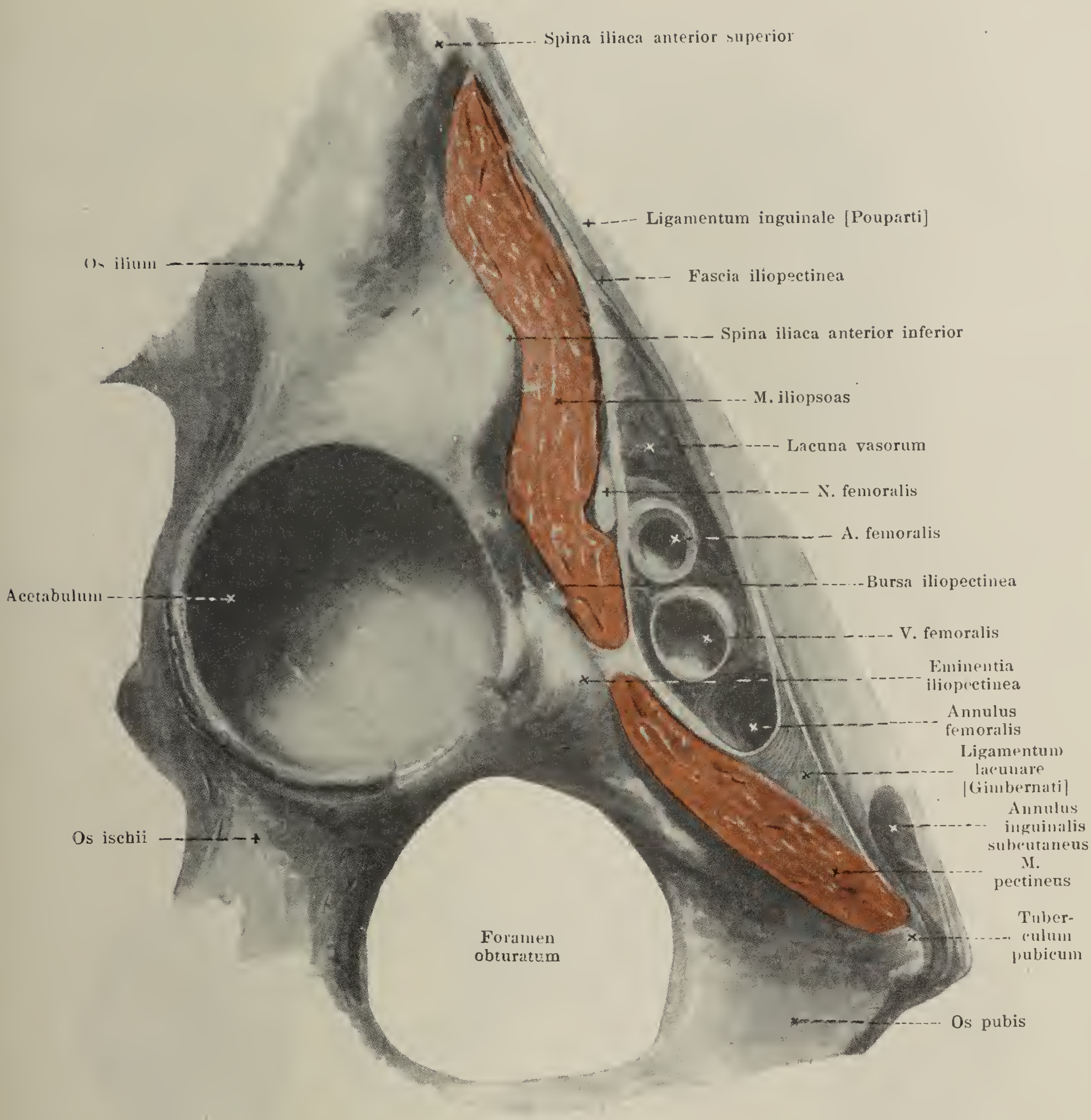

Vagina tendinum mm. extensoris digitorum communis et extensoris indicis
Vagina tendinis m. extensoris pollicis longi
Ligamentum carpi dorsale
Vagina tendinum mm. abductoris longi et extensoris brevis pollicis
Vagina tendinum mm. extensorum carpi radialium
Vagina tendinis m. extensoris carpi ulnaris
Vagina tendinis m. extensoris pollicis longi
Vagina tendinis m. extensoris digiti V
Vagina tendinum mm. extensoris digitorum communis et extensoris indicis
Bursa subcutanea metacarpophalangea dorsalis
Bursae intermetacarpophalangeae

420. Sheaths of the tendons of the back of the right hand, injected and colored red.

Bursae intermetacarpophalangeae, frequent, one to three, are small, lie between two adjacent fingers at the level of the capitula oss. metacarpalium, dorsalward from the ligg. capitulorum transversa, between the 2nd and the 5th finger.

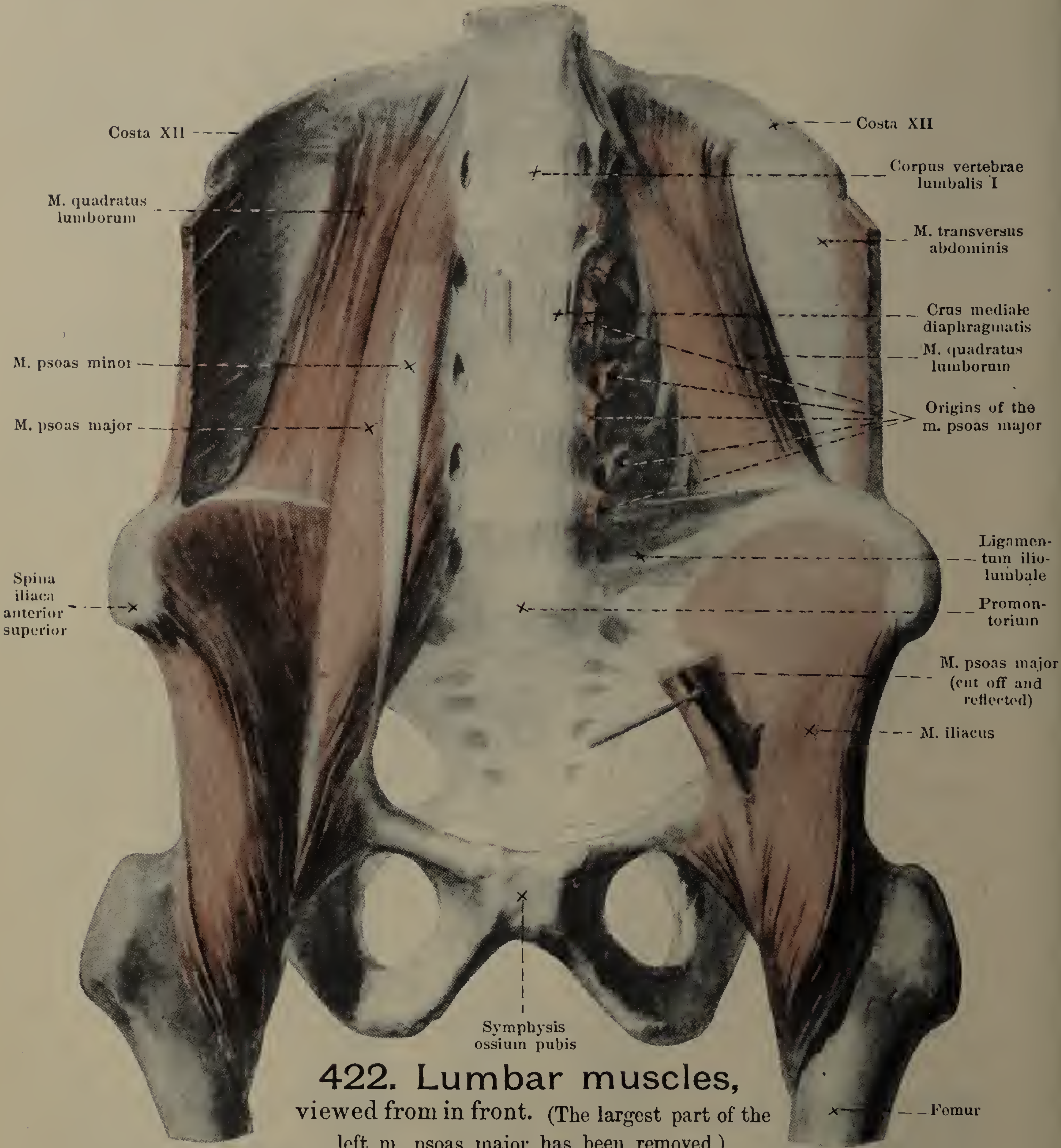
Bursae subcutaneae metacarpophalangeae dorsales occur on the back of the articulationes metacarpophalangeae, usually only on the 5th finger.

Bursae subcutaneae digitorum dorsales (see Fig. 412), just beneath the skin on the back of the articulationes digitorum, usually small, occuring constantly or almost constantly on the first finger joints (between the first and the second phalanx), occasionally on the second joint of the 2nd and 4th finger.



421. Section through the muscles of the right inguinal region, parallel to and directly under the lig. inguinale [Pouparti].

Fascia iliaca (see also Fig. 423). It covers the entire free surface of the m. iliopsoas, begins above very thinly on the arcus lumbocostalis medialis [Halleri], on the bodies of the lumbar vertebrae and on the crista iliaca, is strongest below, and passes over medianward into the fascia pelvis. Below the lateral portion of the lig. inguinale [Pouparti] it extends downward with the m. iliopsoas, is attached lateralward to the spina iliaca anterior superior and to the lig. inguinale, medianward to the eminentia iliopectinea and is named, from this point on, the *fascia iliopectinea.* This divides the space under the lig. inguinale into two compartments, a lateral, *lacuna musculorum,* for the m. iliopsoas and n. femoralis, and a medial, *lacuna vasorum;* the latter contains lateralward the a. femoralis (in front of it the n. lumboinguinalis), medianward the v. femoralis and, between the latter and the lateral concave edge of lig. lacunare [Gimbernati], the *annulus femoralis,* which is closed by the fascia transversalis *(septum femorale [Cloqueti])* and serves for the passage of lymph vessels. Below the lig. inguinale the fascia iliopectinea covers the floor of the fossa iliopectinea and forms at the same time the deep layer of the fascia lata (see also p. 348).

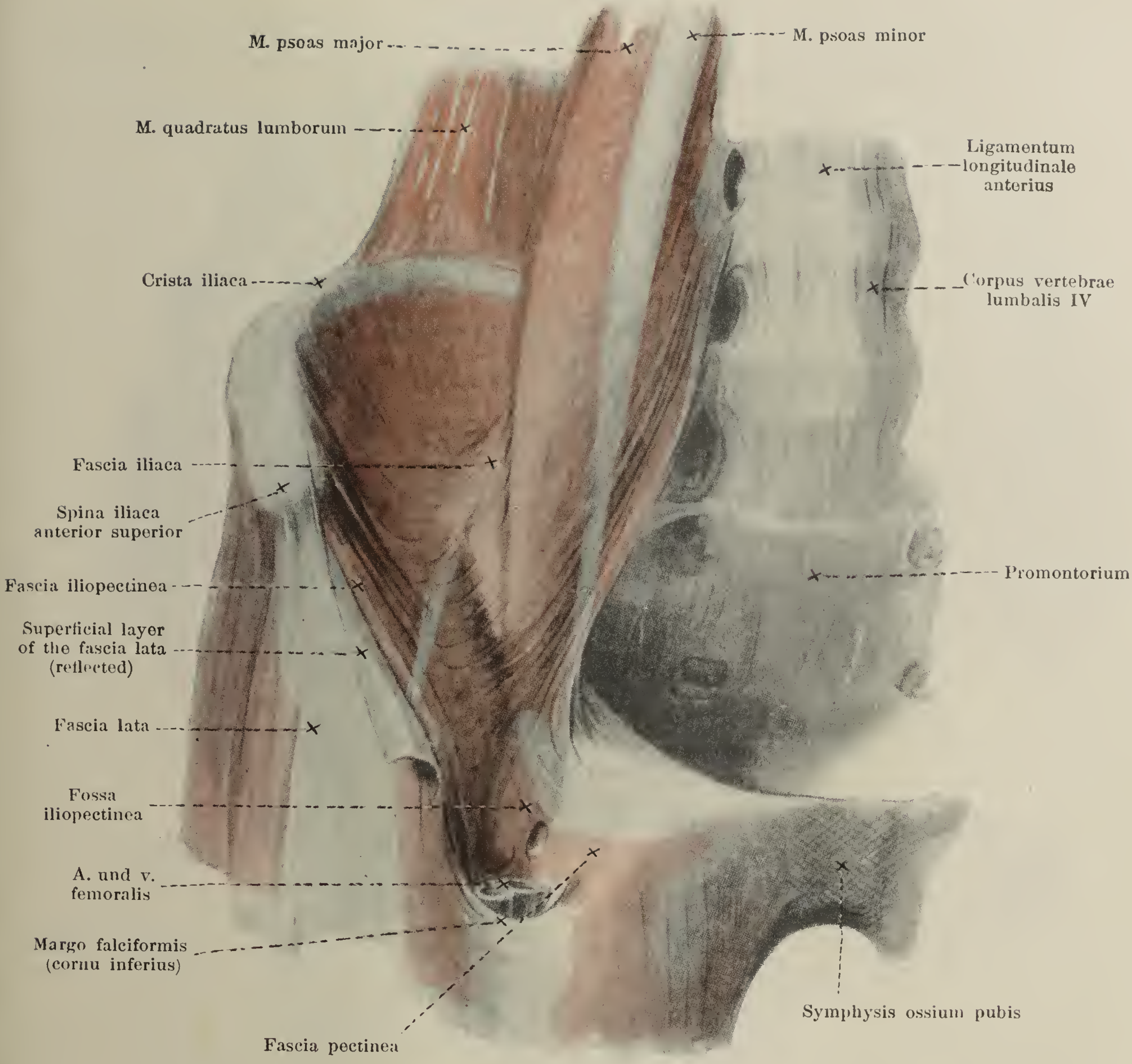


422. Lumbar muscles,
viewed from in front. (The largest part of the left m. psoas major has been removed.)

M. quadratus lumborum (see also Figs. 365, 366 and 384). Form: flat, oblong-quadrangular. Position: in the posterior wall of the peritoneal cavity, directly in front of the fascia lumbodorsalis, covered partly in front by the m. psoas major. Two, often slightly separated, very variable layers. *Anterior layer.* Origin: labium internum cristae iliacae, lig. iliolumbale, procc. transversi of the 5th—2nd lumbar vertebra. Insertion: inferior border of the 12th rib and the body of the 12th thoracic vertebra. *Posterior layer.* Origin: labium internum cristae iliacae and lig. iliolumbale. Insertion: procc. transversi of the 4th—1st lumbar vertebra and inferior margin of 12th rib. Action: it draws the last rib downward; it bends the lumbar spine lateralward and dorsalward. Innervation: rami musculares plexus lumbalis (Th_{12}, L_1, L_2, L_3).

M. iliopsoas consists of *m. psoas minor*, *m. psoas major* and *m. iliacus.*

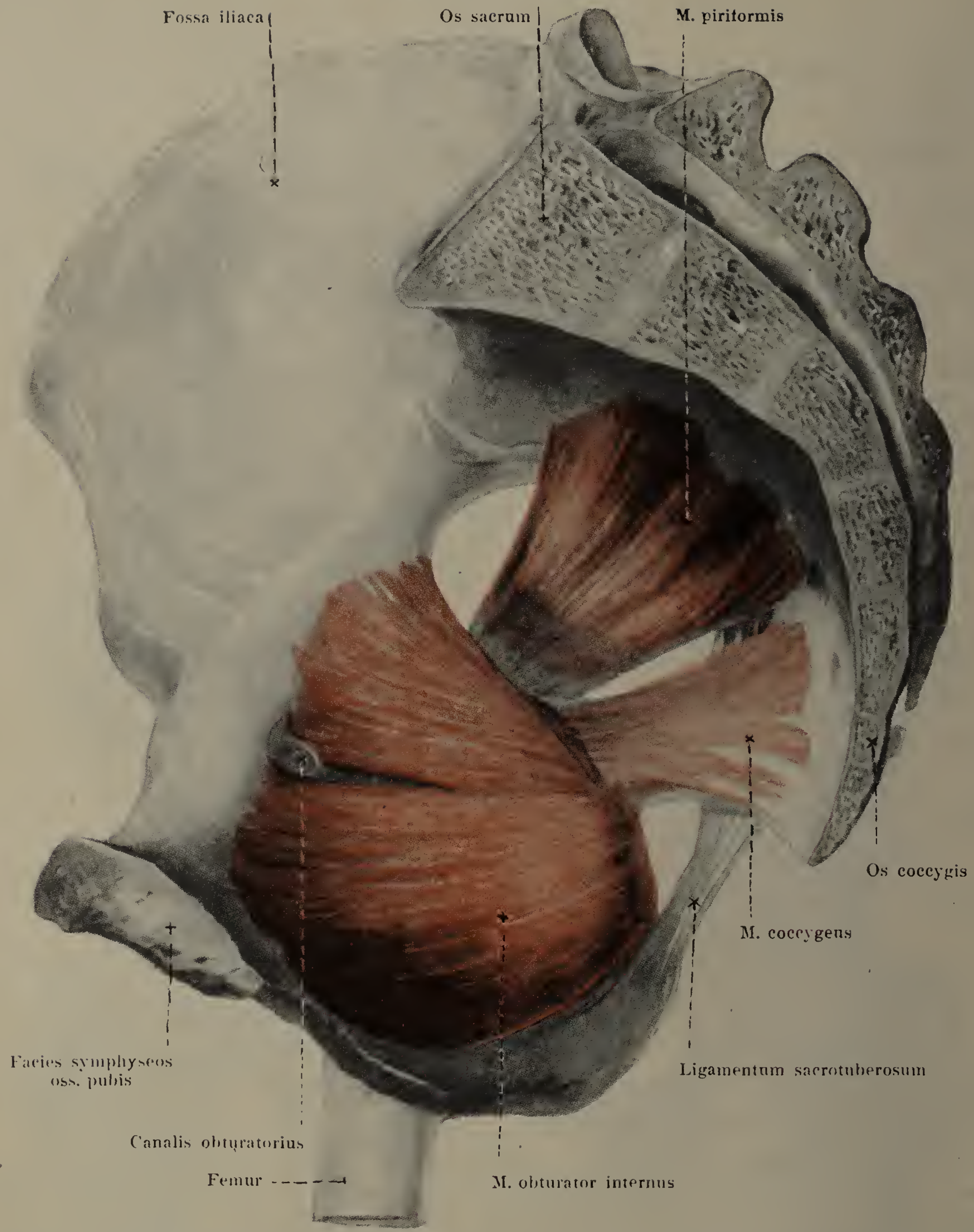
M. psoas minor (see also Figs. 365, 366 and 384), inconstant. Form: flat, long, narrow. Position: directly in front of the m. psoas major. Origin: lateral surface of the bodies of the 12th thoracic and 1st lumbar vertebra and intervertebral disc between them. Insertion: fascia iliaca. Action: it bends the lumbar spine lateralward and forward and makes the fascia iliaca tense. Innervation: rami musculares plexus lumbalis (L_1, L_2).



423. Fascia iliaca dextra.

M. psoas major (see Figs. 365, 366, 384, 421, 422 and 427). Form: round, oblong-triangular. Position: in the posterior wall of the peritoneal cavity, directly in front of the mm. quadratus lumborum and iliacus, just lateral from the lumbar vertebrae and the apertura pelvis superior, the latter projecting a trifle. Origin: lateral surfaces of the bodies and intervertebral discs of the 12th thoracic to the 4th lumbar vertebra, small tendinous arches bridging over the aa. and vv. lumbales, as well as the procc. transversi of the lumbar vertebrae. Insertion: converging downward, forward and lateralward and then, fused with the m. iliacus, with a narrow tendon to the trochanter minor femoris also dorsalward. Action: it bends the lumbar spine lateralward and forward; it flexes the thigh considerably and rotates it slightly outward or, when the latter is fixed, it bends the pelvis and the body forward. Innervation: rami musculares plexus lumbalis and n. femoralis (L_2, L_3, L_4).

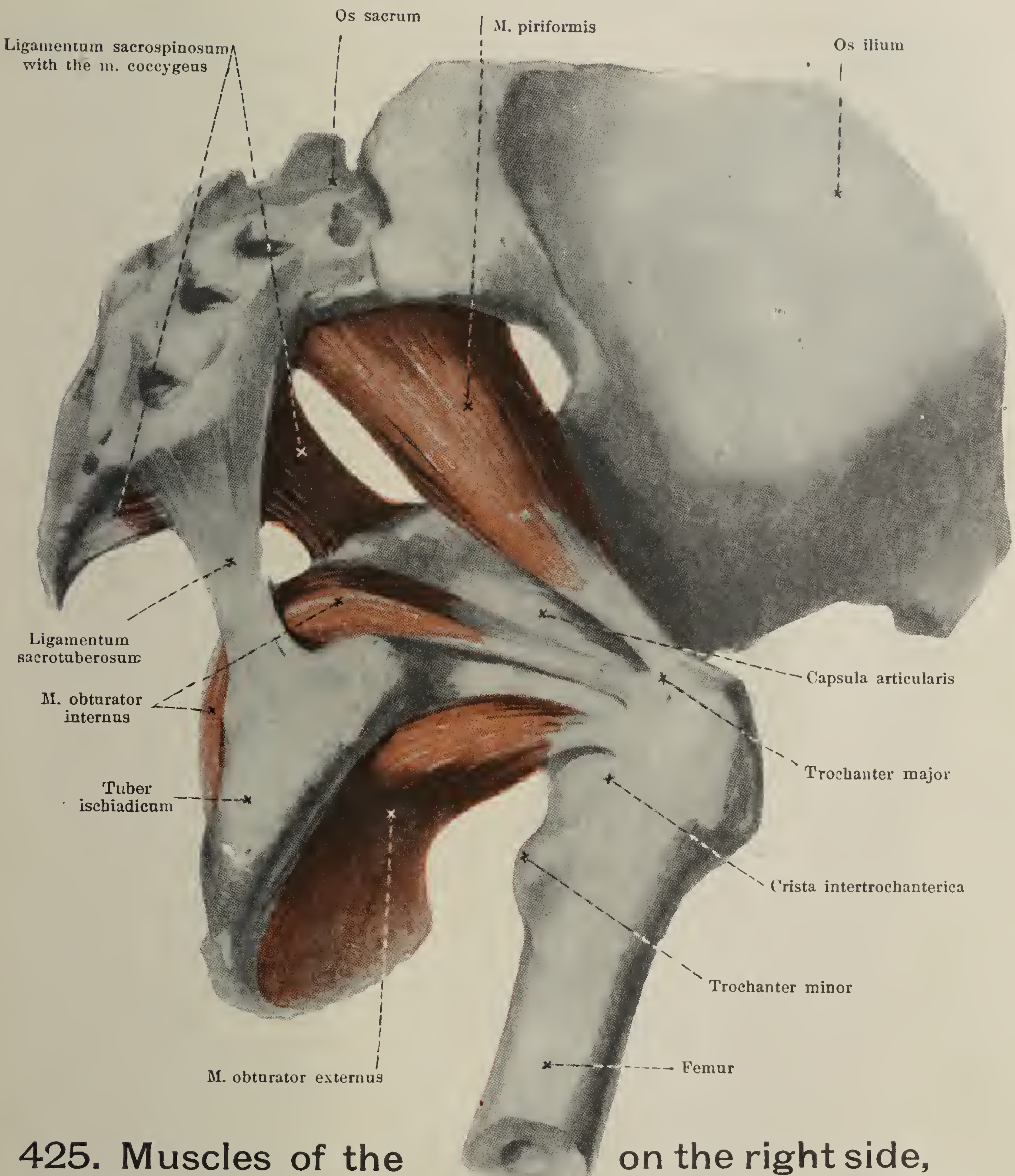
M. iliacus (see also Figs. 365, 421, 422 and 427). Form: flat, triangular. Position: in the fossa iliaca and anterior to the hip-joint, covered medianward by the m. psoas major. Origin: fossa iliaca, inferior circumference of the spina iliaca anterior inferior and capsule of the hip-joint; the latter origin (see Fig. 428) is also designated as the third head of the m. iliopsoas. Insertion: the fibres converge downward in front of the hip-joint *(bursa iliopectinea* see p. 350), then backward in common with the m. psoas major to the trochanter minor femoris *(bursa iliaca subtendinea* see p. 351). Action: it flexes considerably the thigh and rolls it a trifle outward or, when this is fixed, it draws the pelvis, together with the body, forward. Innervation: rami musculares n. femoralis (L_3, L_4).



424. Muscles of the true pelvis on the right side, viewed from within.

M. obturator internus (see also Figs. 425 and 436). Form: flat, triangular. Position: in the interior of the true pelvis, on its lateral wall and close behind the hip-joint. Origin: medial surface of the membrana obturatoria and of the os coxae in the region of the foramen obturatum. Insertion: the fibres converge to the incisura ischiadica minor; there they bend lateralward *(bursa m. obturatoris interni* see p. 361) at a right angle and, becoming tendinous, pass between the two mm. gemelli to the fossa trochanterica femoris. Action: it rotates the thigh outward, adducts and extends it somewhat. Innervation: rami musculares of the plexus sacralis (L_5, $\mathbf{S_1}$, S_2 [S_3]).

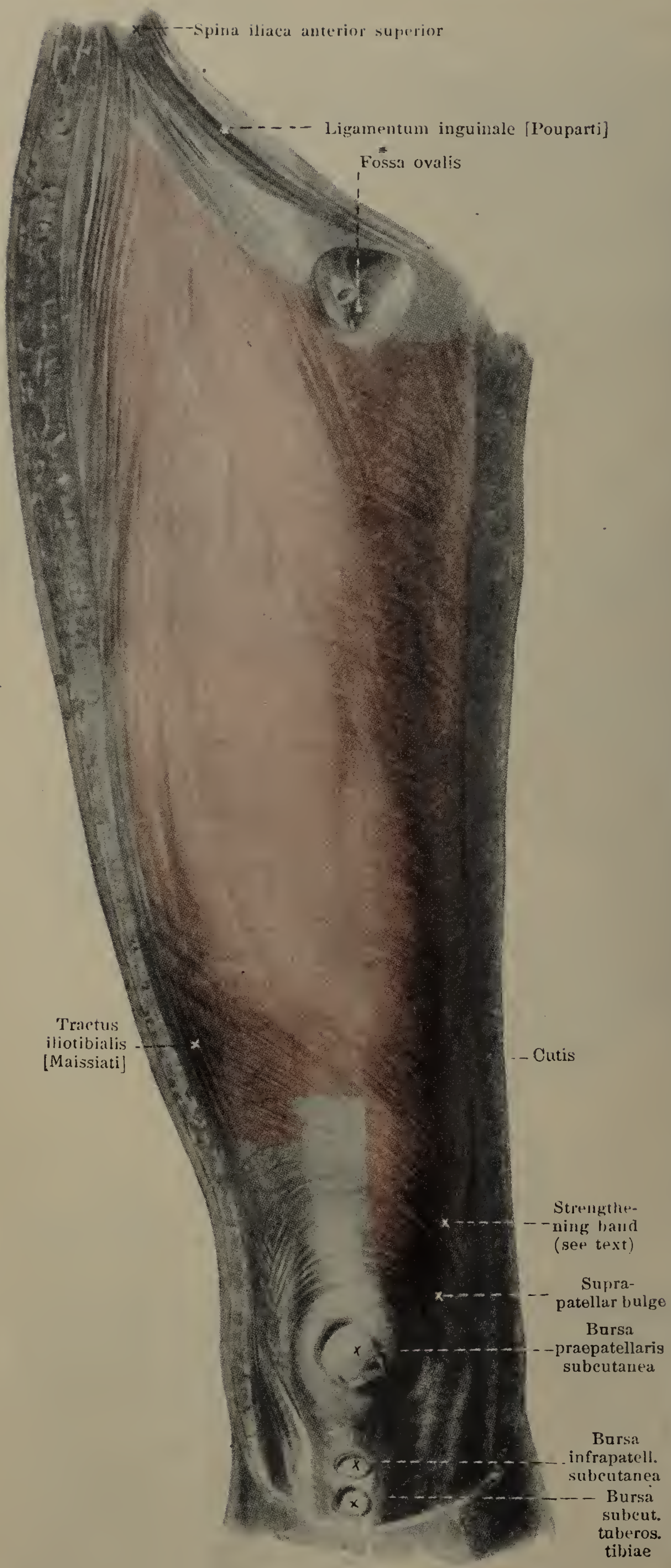
M. coccygeus (see also Figs. 425, 723 and 724). Form: quadrangular, thin. Position: on the anterior surface of the lig. sacrospinosum, forming with it a common mass of very variable composition (see p. 212). Origin: spina ischiadica. Insertion: lateral edge of lower sacral and upper coccygeal vertebrae. Innervation: ramus muscularis of the plexus pudendus (S_3, S_4 [S_5]).



425. Muscles of the true pelvis on the right side, viewed from without and below.

M. obturator externus (see also Figs. 429—431). Form: triangular, thick. Position: anterior surface of the small pelvis and beneath the hip-joint; greatly concealed; covered in front by the mm. iliopsoas, pectineus and adductores brevis et minimus, behind of the mm. quadratus femoris and glutaeus maximus. Origin: anterior surface of the membrana obturatoria and of the os coxae in the region of the foramen obturatum. Insertion: converging lateralward to the fossa trochanterica femoris. Action: it rolls the thigh outward; it flexes it and adducts it. Innervation: n. obturatorius (L_3, L_4).

M. piriformis (see also Figs. 424, 436 and 437). Form: flatly-rounded, triangular. Position: behind the hip-joint bordering above upon the m. glutaeus minimus, below upon the gemellus superior. Origin: facies pelvina oss. sacri, the 2nd—4th foramen sacrale anterius embracing laterally; the upper part of the incisura ischiadica major. Insertion: the fibres run, converging, through the foramen ischiadicum majus (see also p. 212) lateralward to the tip of the trochanter major femoris *(bursa m. piriformis* see p. 361). Action: it abducts the thigh outward, rolls it and extends it somewhat backward. Innervation: rami musculares plexus sacralis (S_1, S_2, S_3).


Spina iliaca anterior superior
Ligamentum inguinale [Pouparti]
Fossa ovalis
Tractus iliotibialis [Maissiati]
Cutis
Strengthening band (see text)
Suprapatellar bulge
Bursa praepatellaris subcutanea
Bursa infrapatell. subcutanea
Bursa subcut. tuberos. tibiae

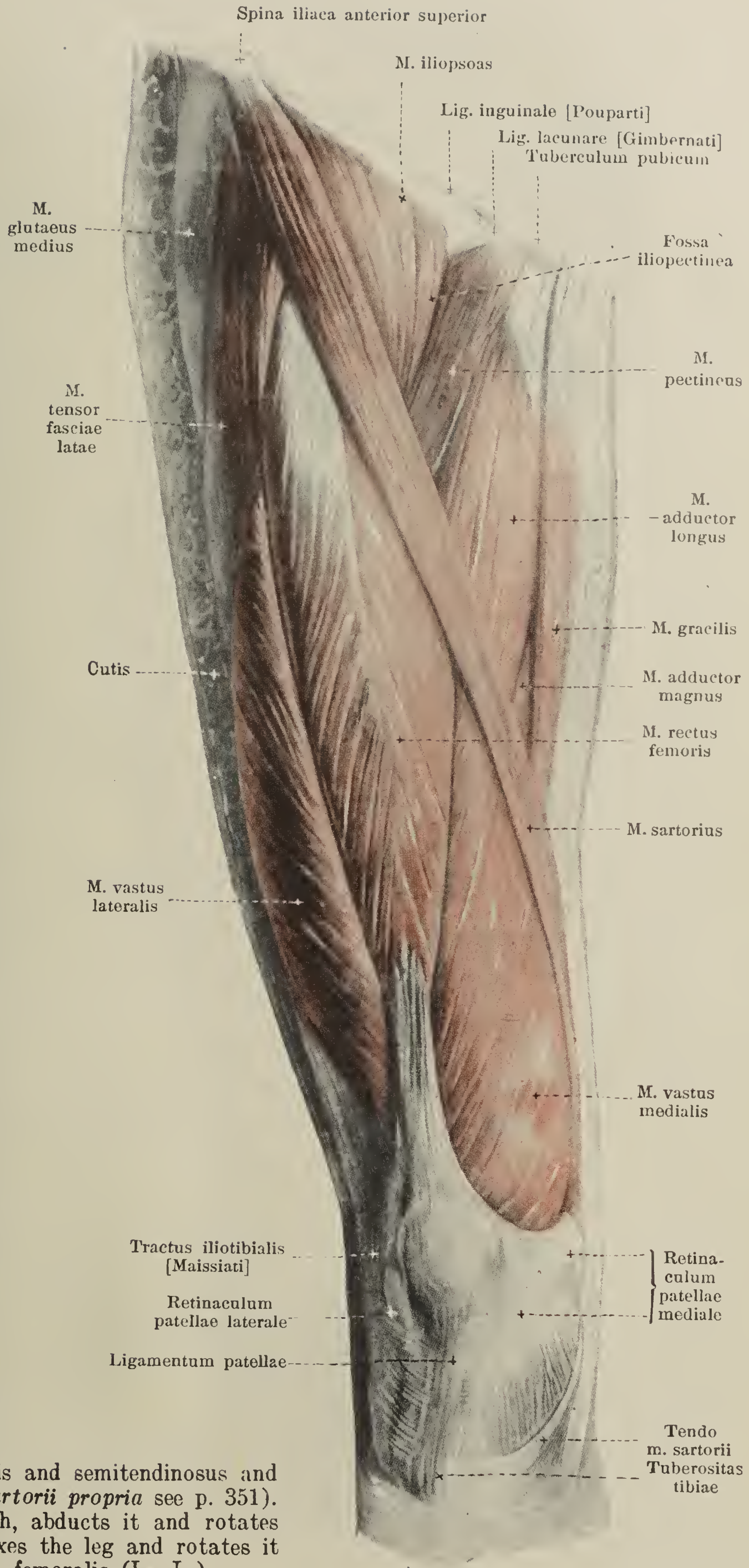
426. Fascia of the right thigh,

viewed from in front.

Fascia lata [anterior half] (see also Figs. 376, 423 and 874) covers the free surface of the muscles of the thigh and is stronger lateralward and above. From near the knee a strong fibrous process runs from the region of the epicondylus medialis femoris divergingly upward and lateralward, a furrow in the skin corresponds to this when the knee is passively over extended and the muscles are relaxed; below this furrow the lowermost part of the m. vastus medialis projects as an oblong bulge running obliquely upward and lateralward *(suprapatellar bulge).* The fascia also forms a sheath for the m. sartorius behind and divides above into a deep and a superficial layer. The deep layer covers the *fossa iliopectinea.* This (see Figs. 423 and 427) possesses a triangular entrance, comes in relation above with the lig. inguinale, laterally with the m. sartorius and ends below under the latter; lateralward it is bounded by the m. iliopsoas, medianward by the m. pectineus; above it is continued into the lacuna vasorum. It is the lateral part of the larger, triangular *trigonum femorale [fossa Scarpae major]* (O. T. Scarpa's triangle), which is limited above by the lig. inguinale, laterally by the m. sartorius, and medially by the medial edge of the m. adductor longus. Lateralward the deep layer is identical with the *fascia iliopectinea* (see p. 343), and medianward, upon the m. pectineus, it is called the *fascia pectinea.* The superficial layer passes from the upper edge of the m. sartorius to the lower edge of the lig. inguinale and partially covers the fossa iliopectinea. It ends medianward with a concave, spiral-shaped edge, *margo falciformis* (O. T. falciform ligament) which arises below from the fascia pectinea *(cornu inferius),* is often indistinctly outlined in its middle portion and, above *(cornu superius),* runs medianward to the lig. inguinale and the lig. lacunare.

427.
Muscles of the right thigh,

viewed from in front.



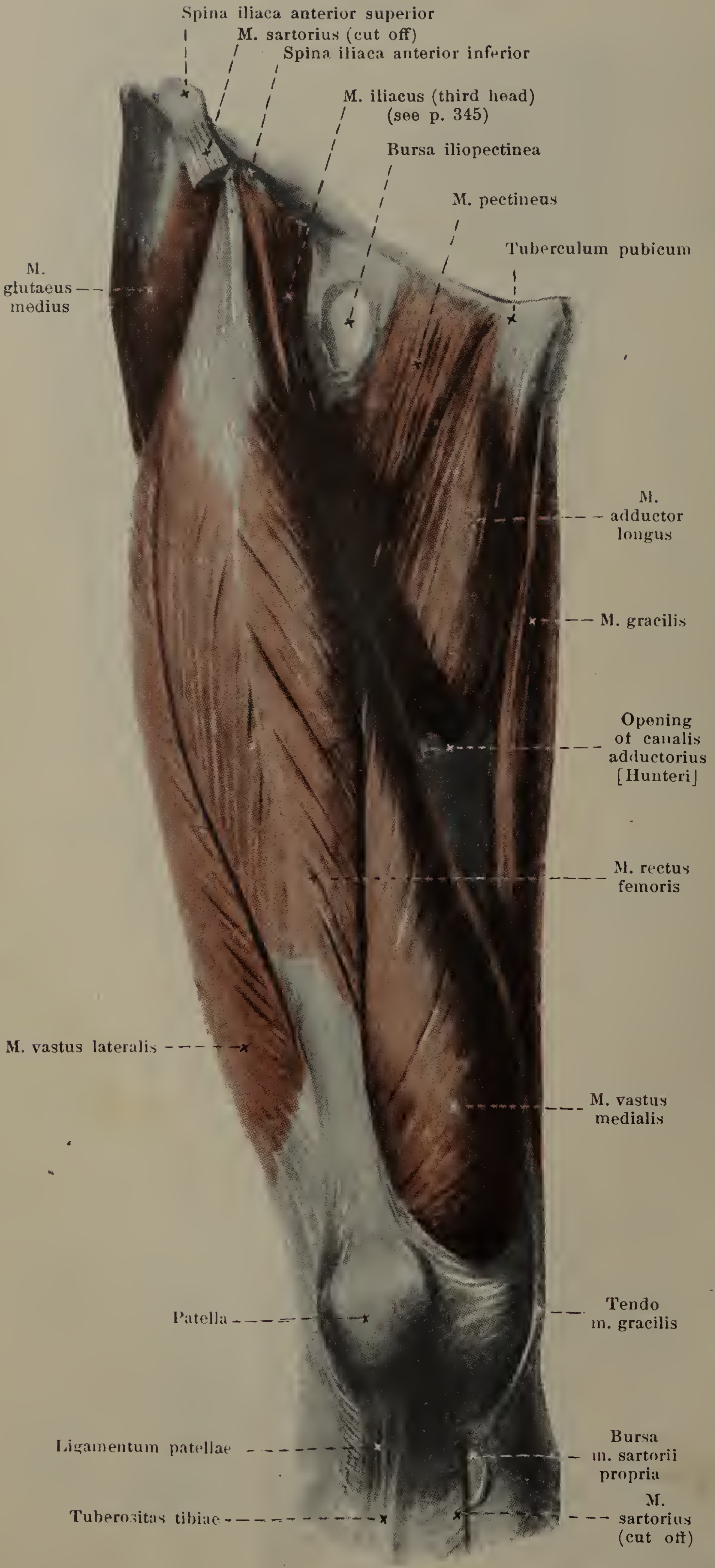
Fascia lata (continued). The fossa bounded by the margo falciformis is called the *fossa ovalis;* it is covered by the *fascia cribrosa,* a deep layer of the fascia superficialis which extends from the margo falciformis to the fascia pectinea and presents openings for lymph glands and vessels. The space from the annulus femoralis as far as the entrance to the fossa ovalis is called also the *canalis femoralis.*

Bursae praepatellares see p. 232.

Bursa infrapatellaris subcutanea (see Fig. 426), frequently present, just beneath the skin, in front of the lig. patellae.

Bursa subcutanea tuberositas tibiae (see Fig. 426), frequently present, in front of the tuberositas tibiae.

M. sartorius (see also Fig. 439). Form: flat, narrow, very long. Position: superficial, in a long spiral above on the anterior, below on the medial surface of the thigh. Origin: by a short tendon from the spina iliaca anterior superior. Insertion: the fibres run parallel, at first medianward and downward in front of the m. iliopsoas and in front of the groove between the m. quadriceps and the mm. adductores, then downward medial from the m. vastus medialis in front of the m. gracilis, then behind the epicondylus medialis, and thence obliquely forward with a flat, diverging tendon to the tuberositas tibiae and fascia cruris; the tendon covers the insertions of the mm. gracilis and semitendinosus and fuses with them (*bursa m. sartorii propria* see p. 351). Action: it flexes the thigh, abducts it and rotates it somewhat outward; it flexes the leg and rotates it inward. Innervation: n. femoralis (L_2, L_3).



428.

Muscles of the right thigh,

viewed from in front.

(The mm. sartorius and tensor fasciae latae have been completely, the m. iliopsoas for the most part removed.)

Bursa iliopectinea (see also Fig. 421), constant, large, between the m. iliopsoas and the lig. iliofemorale; it is sometimes connected with the cavity of the hip-joint.

M. pectineus (see also Figs. 421 and 427). Form: flat, oblong-quadrangular. Position: medial from and below the hip-joint, bounded lateralward by the m. iliopsoas, medianward by the m. adductor longus, behind by the mm. adductor brevis and obturator externus, covered at the insertion by the m. sartorius. Origin: fleshy from the ramus superior oss. pubis, pecten oss. pubis and ligamentum pubicum superius (see p. 215). Insertion: parallel downward, lateralward and backward to the linea pectinea femoris (*bursa m. pectinei* see p. 351). Action: it adducts and flexes the thigh, and rotates it slightly outward. Innervation: n. femoralis, rarely also ramus anterior n. obturatorii (L_2, L_3).

M. gracilis (see also Figs. 427, 435, 437 and 439). Form: flat, long, thin. Position: superficial, on the medial surface of the thigh, medianward from the mm. adductores; behind it is bounded by the m. semimembranosus. Origin: by a broad, very thin tendon from the ramus inferior oss. pubis and oss. ischii. Insertion: parallel downward, behind the epicondylus medialis femoris and thence forward by a thin tendon to the tuberositas tibiae, just behind the tendon of the m. sartorius (*bursa anserina* see p. 351). Action: it adducts the thigh and flexes it somewhat; it flexes the leg and rotates it inward. Innervation: ramus anterior n. obturatorii (L_2, L_3, L_4).

429. Muscles of the right thigh, viewed from in front.

(The mm. sartorius, tensor fasciae latae, pectineus and gracilis have been removed; the knee-joint has been opened on the medial side.)

M. quadriceps femoris consists of four muscles, which are partly separated above, but inseparably united at their insertion: *m. rectus femoris, m. vastus lateralis, m. vastus intermedius* and *m. vastus medialis.* Innervation: n. femoralis (L_2, L_3, L_4).

M. rectus femoris (see also Figs. 427 and 428). Form: spindle-shaped, thick, bipinnate. Position: on the anterior surface of the thigh, covered above by the m. sartorius, otherwise superficial. Origin: tendinous, partly from the spina iliaca anterior inferior, partly arch-like above the acetabulum *(bursa m. recti femoris* see p. 352). Insertion: the fibres diverge from a middle tendon and run distalward to a tendon beginning on the dorsal surface where it goes over above the patella into the common tendon. Action: it flexes the thigh and abducts it; it extends the leg.

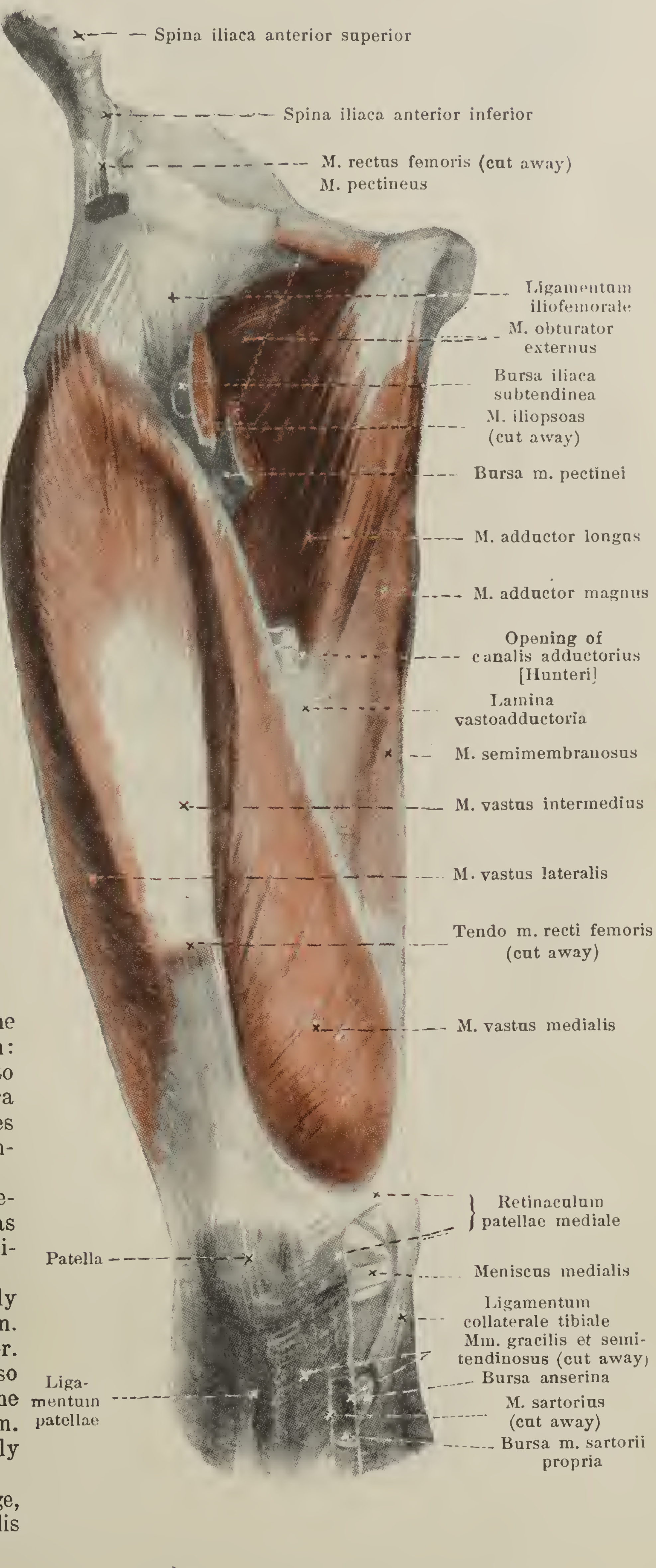
M. adductor longus (see also Figs. 427 and 428). Form: flat, oblong-triangular, thick. Position: on the anterior surface of the thigh, bounded behind by the mm. adductores brevis et magnus, medially by the m. gracilis, laterally above by the m. pectineus, separated from it below by a triangular hollow which varies in size; behind it is covered by the m. sartorius. Origin: by a thick, long tendon from the anterior surface of the ramus superior oss. pubis. Insertion: diverging downward and lateralward to the labium mediale of the linea aspera femoris. Action: it adducts and flexes the thigh. Innervation: ramus anterior n. obturatorii (L_2, L_3).

Bursa iliaca subtendinea, very frequently present, between the m. iliopsoas and the trochanter minor; it communicates often with the hip joint.

Bursa m. pectinei, very frequently present, between the m. pectineus and m. iliopsoas, just below the trochanter minor.

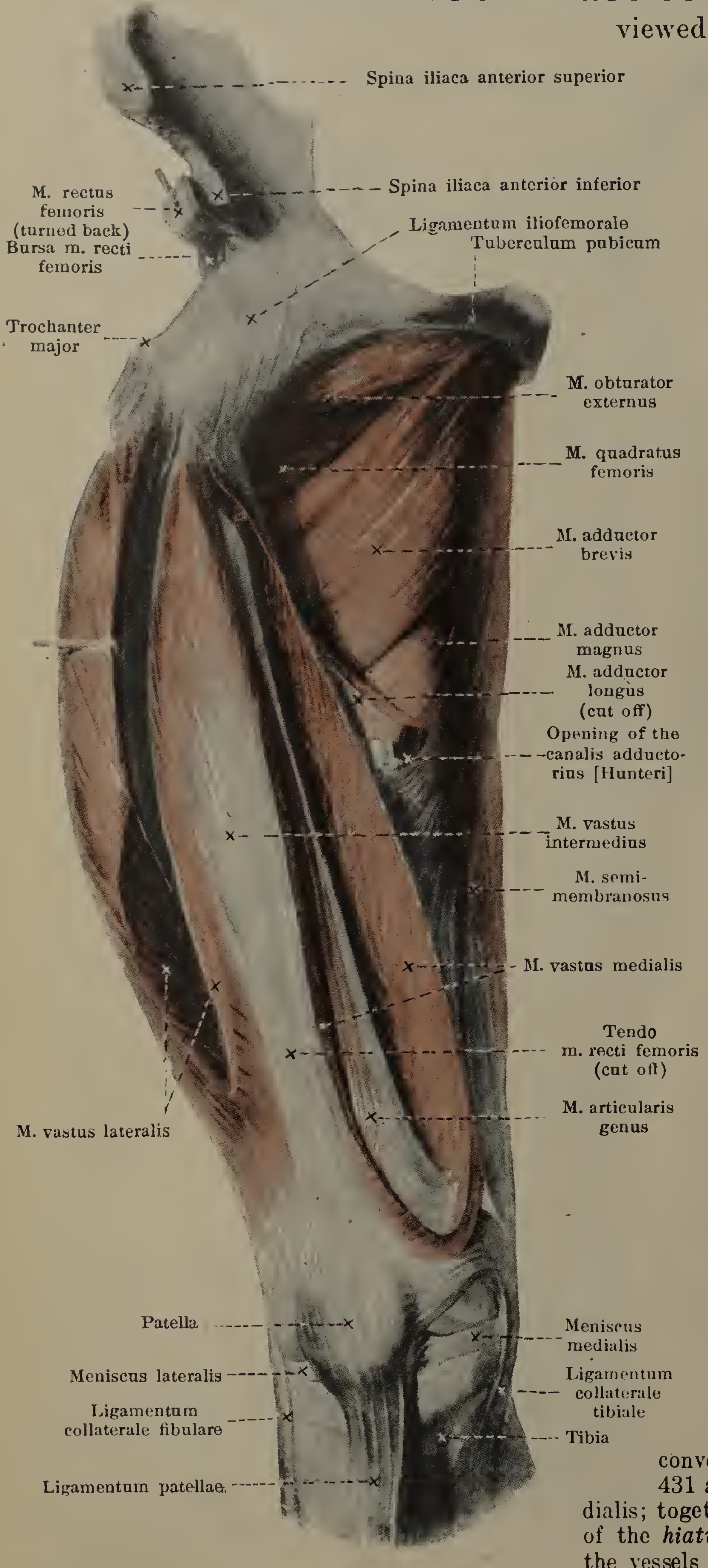
Bursa m. sartorii propria (see also Fig. 428), between the tendon of the m. sartorius and the tendons of the mm. gracilis and semitendinous; not rarely connected with the

Bursa anserina, constant, large, between the tendons of the mm. gracilis and semitendinosus and the tibia.



430. Muscles of the right thigh,

viewed from in front.



(Like Fig. 429); in addition the m. adductor longus has been entirely, the mm. vasti medialis and lateralis have been partially removed; the knee-joint has been opened.)

M. adductor brevis. Form: triangular, thick. Position: in front covered by the mm. pectineus and adductor longus, above adjoining the m. obturator externus, behind the m. adductor minimus. Origin: fleshy from the anterior surface of the ramus inferior ossis pubis. Insertion: diverging downward and lateralward to the labium mediale of the linea aspera femoris. Action: it adducts and flexes the thigh and rotates it somewhat outward. Innervation: ramus anterior et posterior n. obturatorii (L_2, L_3, L_4).

M. adductor minimus (O. T. upper portion of adductor magnus) (see Figs. 431 and 436—438). Form: triangular, thick. Position: behind the preceding, bounded above by the mm. obturator externus and quadratus femoris, below by the m. adductor magnus, behind by the latter and the m. glutaeus maximus. Origin: anterior surface of the rami inferiores ossis pubis and ossis ischii. Insertion: diverging lateralward and downward to the labium mediale of the linea aspera femoris. Action: it adducts the thigh and flexes it somewhat. Innervation: ramus posterior n. obturatorii (L_2, L_3, L_4).

M. adductor magnus (see Figs. 427, 429, 431, 435, 437 and 438). Form: triangular, thick. Position: on the medial side of the thigh, in front covered by the mm. adductores brevis et longus and sartorius, bounded above and in front by the m. adductor minimus, medianward by the m. gracilis and posteriorly by the mm. semimembranosus, semitendinosus and biceps; it lies above between the m. gracilis and the mm. semitendinosus and semimembranosus over a certain distance superficially (see Fig. 442). Origin: fleshy from the anterior surface of the ramus inferior oss. ischii and tuber ischiadicum. Insertion: the upper, anterior fibres diverge lateralward and downward to the labium mediale of the linea aspera femoris (see also p. 354), the lower, posterior fibres converge downward to a thick tendon (see Figs. 431 and 438) which runs to the epicondylus medialis; together with the femur it forms the boundaries of the *hiatus tendineus [adductorius]* through which the vessels of the thigh pass (see also p. 354). Action: it adducts and extends the thigh. Innervation: ramus posterior n. obturatorii and n. tibialis (total L_2, L_3, L_4, L_5, S_1).

Bursa m. recti femoris, frequently present, between the tendon of origin of the m. rectus femoris and the acetabulum.

431. Muscles of the right thigh,

viewed from in front.

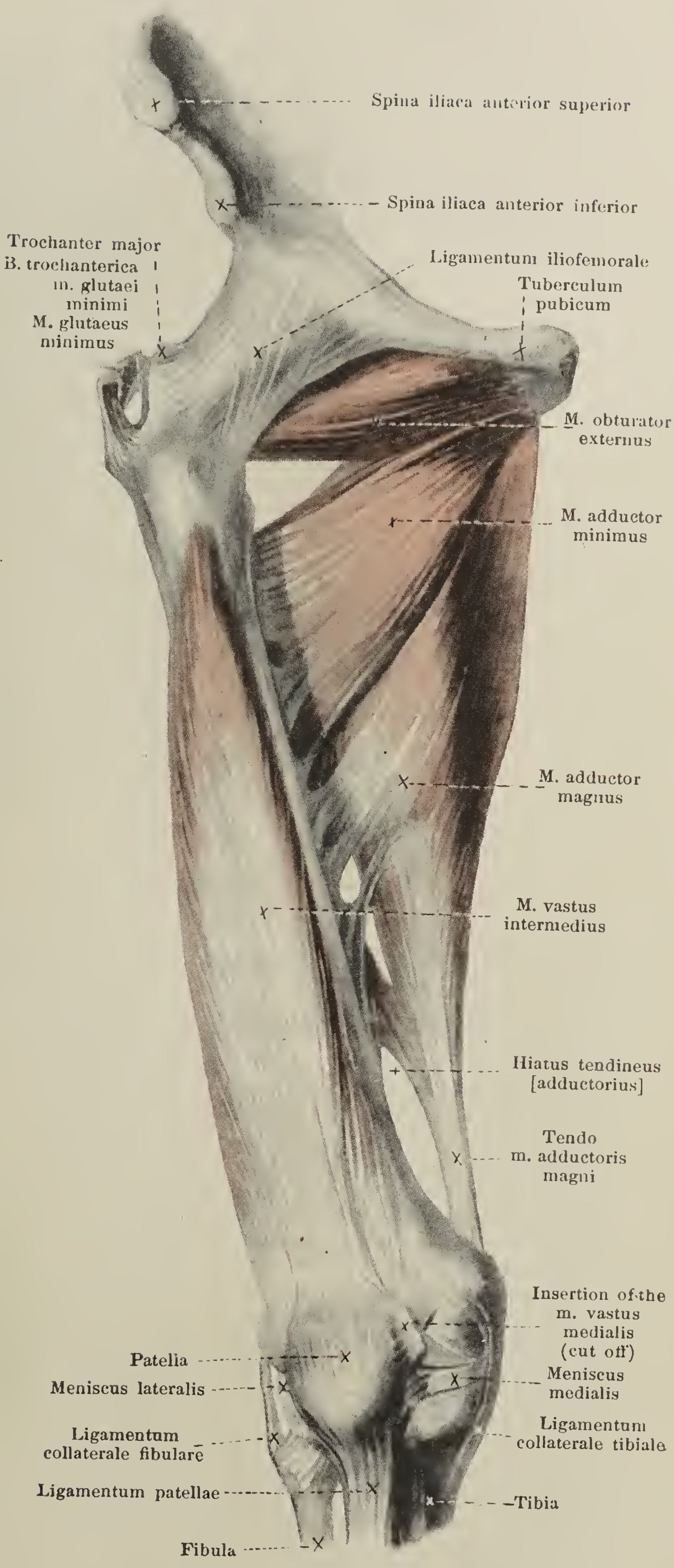
(The muscles have been removed with the exception of the mm. obturator externus, adductores minimus et magnus and vastus intermedius.)

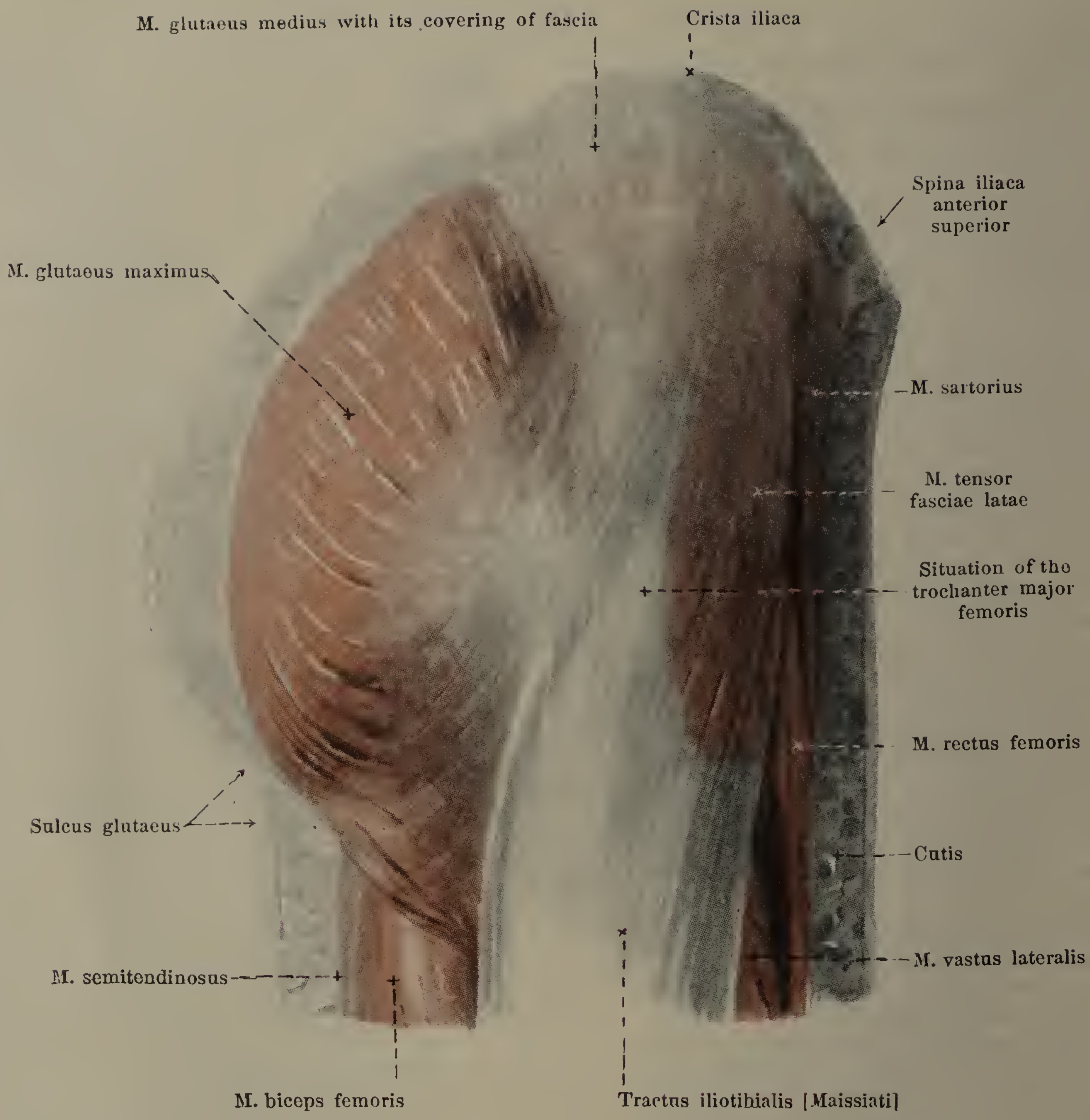
M. vastus intermedius (O. T. cruréus) (see also Figs. 429 and 430). Form: flat, oblong. Position: on the anterior side of the thigh, directly upon the bone; in front covered by the m. rectus femoris; at the sides covered over by the mm. vasti medialis et lateralis, being fused with them partly. Origin: anterior surface of the corpus femoris. Insertion: the fibres run parallel downward, covered in front by a long, thin, flat tendon, and go, above the patella, into the common tendon (see p. 354).

M. articularis genus (O. T. subcrureus) (see Figs. 430, 441 and 443) forms, in a sense, the deepest layer of the preceding muscle. Form: flat, thin. Position: directly upon the lower third of the femur. Origin: anterior surface of the corpus femoris. Insertion: upper and lateral surfaces of the capsule of the knee-joint. Action: it makes this capsule tense. Innervation: n. femoralis (L_3, L_4).

M. vastus lateralis (O. T. vastus externus) (see Figs. 427—430, 438 and 440). Form: flat, bent furrow-like. Position: on the lateral surface of the thigh, chiefly superficial, covered only by the m. tensor fasciae latae and the tractus iliotibialis, bounded behind by the m. biceps femoris, separated from the m. vastus intermedius by a connective tissue layer, which contains the r. descendens a. circumflexae femoris lateralis. Origin: anterior and lateral surface of the trochanter major and labium laterale of the linea aspera femoris. Insertion: the fibres run parallel, in a curve, medianward and downward and are attached partly to a tendinous sheet lying on the medial surface of the muscle, partly, above and lateralward from the patella to the common tendon (see p. 354).

Bursa trochanterica m. glutaei minimi, almost constant, fairly large, between the tendon of the m. glutaeus minimus and the trochanter major femoris.


Spina iliaca anterior superior
Spina iliaca anterior inferior
Trochanter major
B. trochanterica m. glutaei minimi
M. glutaeus minimus
Ligamentum iliofemorale
Tuberculum pubicum
M. obturator externus
M. adductor minimus
M. adductor magnus
M. vastus intermedius
Hiatus tendineus [adductorius]
Tendo m. adductoris magni
Insertion of the m. vastus medialis (cut off)
Patella
Meniscus lateralis
Meniscus medialis
Ligamentum collaterale fibulare
Ligamentum collaterale tibiale
Ligamentum patellae
Tibia
Fibula

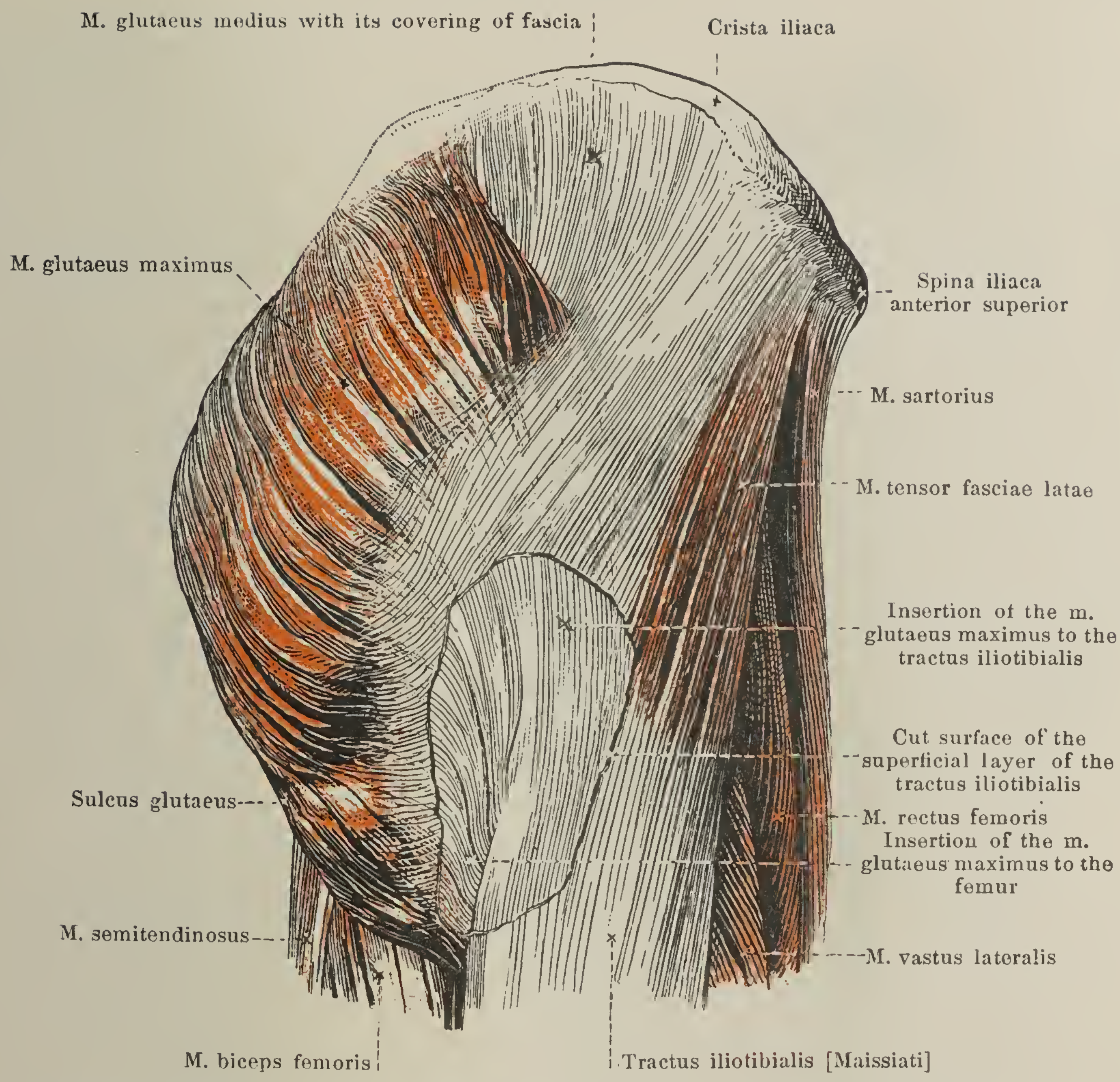


432. External muscles of the right hip,
viewed from the lateral surface.

M. vastus medialis (O. T. vastus internus) (see Figs. 427—430, 438 and 439). Form: flat, bent furrow-like. Position: on the medial and anterior surface of the thigh; covered at its origin by the m. sartorius; otherwise superficial; comes into contact behind with the mm. adductores longus et magnus, anteriorly commonly grown together with the m. vastus intermedius. The muscle layer of the m. vastus medialis reaches further distalwards, than that of the m. vastus lateralis, often below the upper border of the patella. Origin: labium mediale lineae asperae femoris. Insertion: the fibres go, parallel, in a curve, lateralward and downward, partly to the anterior tendinous plate of the m. vastus intermedius, partly, above and medianward from the patella, to the common tendon. From the anterior surface of the m. adductor magnus, approximately from the lower margin of the m. adductor longus on, a tendinous plate, the *lamina vastoadductoria*, goes to the medial surface of the m. vastus medialis; this bridges over a triangular vascular canal, which extends obliquely backward and downward, the *canalis aductorius [Hunteri])* (O. T. Hunter's canal), whose distal aperture, the *hiatus tendineus [adductorius]*, opens into the ham (see also p. 352).

The common tendon of the m. quadriceps femoris is attached to the upper and to the lateral margins of the patella and partly goes over, in front of it, directly into the lig. patellae. Some of the tendon fibres of the mm. vasti medialis and lateralis run however downward beside the patella to the anterior surface of the condyli tibiae and thus form the *retinacula patellae mediale et laterale* (see Figs. 427 and 439), of which the medial one is the broader and the more distinct, and the outer attached to the tractus iliotibialis; to these are also to be added other ligamentous bands which extend from the epicondyli forward to the patella and into which also bands of muscle are inserted.

Action of the mm. vasti: they extend the leg. Innervation of the same: n. femoralis (L_2, L_3, L_4).


M. glutaeus medius with its covering of fascia
Crista iliaca
M. glutaeus maximus
Spina iliaca anterior superior
M. sartorius
M. tensor fasciae latae
Insertion of the m. glutaeus maximus to the tractus iliotibialis
Cut surface of the superficial layer of the tractus iliotibialis
Sulcus glutaeus
M. rectus femoris
Insertion of the m. glutaeus maximus to the femur
M. semitendinosus
M. vastus lateralis
M. biceps femoris
Tractus iliotibialis [Maissiati]

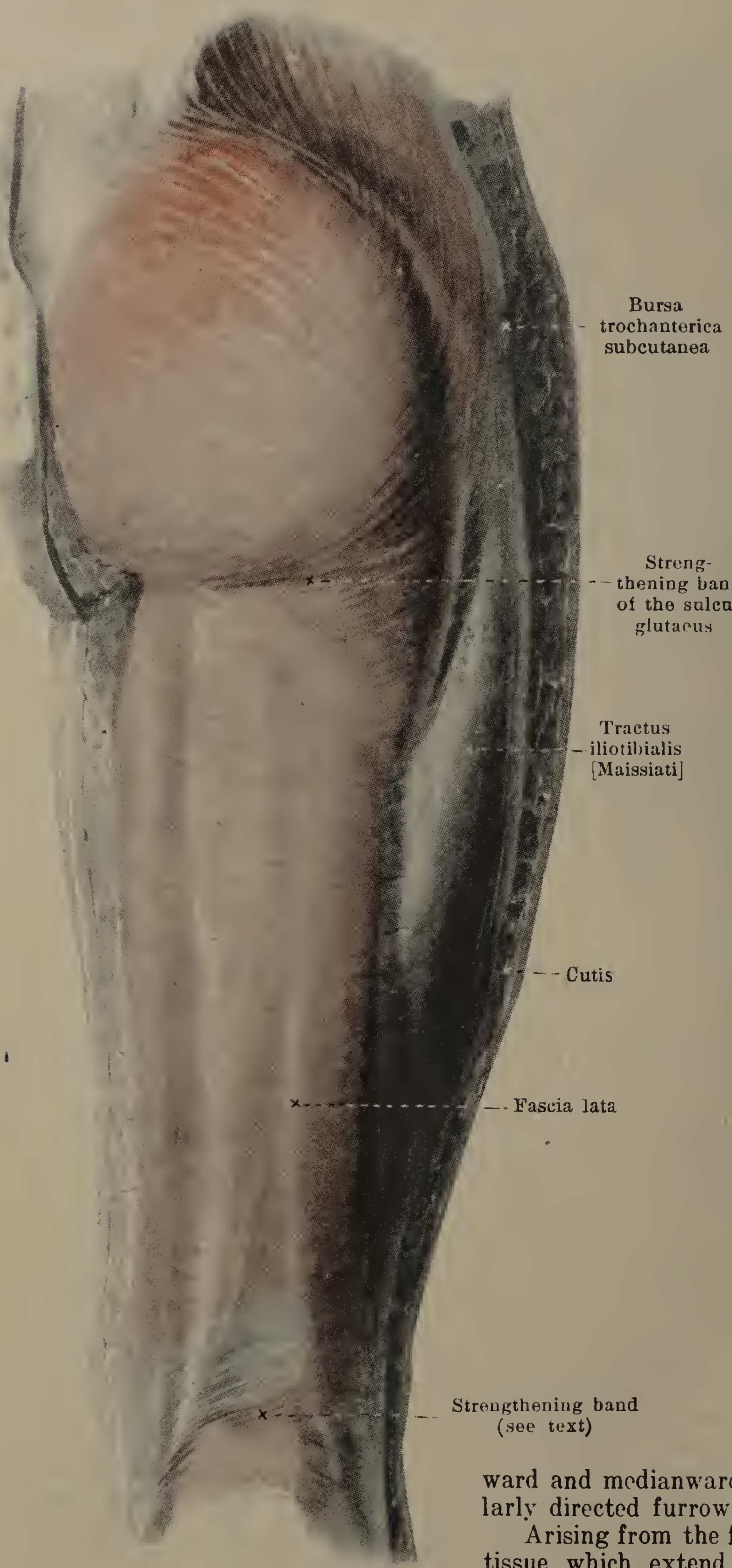
433. External muscles of the right hip,
viewed from the lateral surface.

(In order to show the varying mode of attachment of the m. glutaeus maximus, a piece has been cut out of the superficial layer of the tractus iliotibialis and the deeper layer has been dissected out.)

M. tensor fasciae latae (O. T. tensor vaginae femoralis) (see also Figs. 427 and 432). Form: flat, oblong-quadrangular, thick. Position: on the lateral surface of the hip, just beneath the skin; bounded in front by the mm. sartorius and rectus femoris, medianward and behind by the m. glutaeus medius, and is fused with the latter at the origin. Origin: tendinous from the spina iliaca anterior superior and from the fascia lata. Insertion: the fibres run parallel downward and go over, at the junction of the upper with the middle third of the thigh, into the tractus iliotibialis [Maissiati] (see p. 356). The muscle is covered on its lateral surface by a thin fascia, on its medial surface by a thicker layer of fascia; the latter is attached above at the spina iliaca anterior inferior. Action: it makes the fascia lata tense, especially the tractus iliotibialis; it flexes and abducts the thigh and rotates it somewhat inward; it causes slight extension and outward rotation of the leg. Innervation: n. glutaeus superior, often also n. femoralis (total L4, **L5**, S1 [S2]).

M. glutaeus maximus (see also Figs. 380, 432, 435, 436 and 438). Form: flat, quadrangular, very thick. Position: just beneath the skin of the buttock, the fleshy basis of which it forms. Origin: lateral surface of the ala oss. ilium behind the linea glutaea posterior, fascia lumbodorsalis, the posterior surface of the sacrum and coccyx and their ligaments, as well as the lig. sacrotuberosum. Insertion: the fibres run, nearly parallel, lateralward and downward; those of the upper portion go, in the form of a broad tendon, over the lateral surface of the trochanter major femoris *(b. trochanterica m. glutaei maximi* see p. 361), curve downward and pass over into the deep layer of the tractus iliotibialis [Maissiati], hidden by the superficial layers of the same; the fibres of the lower portion are attached by a thick, flat tendon to the tuberositas glutaea femoris *(bursae glutaeofemorales* see p. 361). Action: it extends the thigh backward, rotates it outward and adducts it; it makes the fascia lata tense, especially the tractus iliotibialis; the muscles of both sides press, at fixed standing thighs, the buttocks together. Innervation: n. glutaeus inferior ([L4] L5, **S1**, S2).

434. Fascia of the right thigh,
viewed from behind.


Bursa trochanterica subcutanea
Strengthening band of the sulcus glutaeus
Tractus iliotibialis [Maissiati]
Cutis
Fascia lata
Strengthening band (see text)

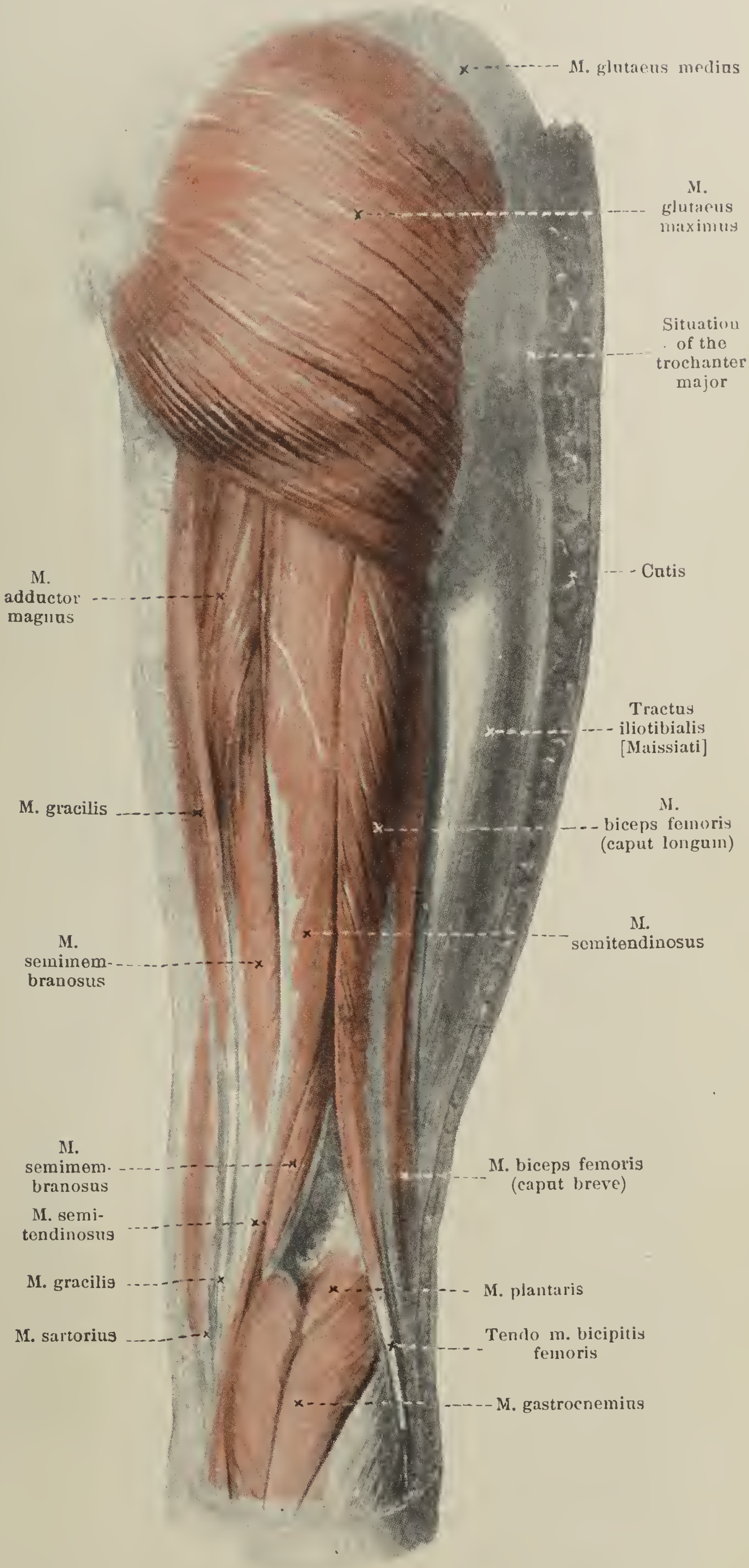
Fascia lata (posterior half) (see also Figs. 432, 433 and 440) is, upon the posterior surface of the m. glutaeus maximus, in general thin; distalward it is somewhat thicker. Interwoven in the fascia along the lateral surface, from the lower end of the m. tensor fasciae latae on, and from the m. glutaeus maximus is a broad, thick, glistening, tendinous strip of parallel fibres, the ***tractus iliotibialis [Maissiati]*** (O. T. iliotibial band), which is attached below to the condylus lateralis tibiae. This strip consists above (see Fig. 433) of a deep layer, which is the direct continuation of tendinous fibres of the m. glutaeus maximus, and of a superficial layer, which consists partly of tendinous fibres of the m. tensor fasciae latae, partly of fibres which descend from the thick fascial covering of the m. glutaeus medius. From the latter region comes also a thicker, flat bundle which crosses the insertion of the m. glutaeus maximus and extends in a curve from above downward and medianward to the tuber ischiadicum. This strand, cutting deep into the muscle, corresponds to the *sulcus glutaeus* (O. T. gluteal groove), which is visible as a furrow, running transversely in the skin when the m. glutaeus maximus is contracted (at the standing leg and, when standing on both feet, at both legs). A less marked strengthening band, in the popliteal space, extends from above and lateralward downward and medianward and corresponds also to a similarly directed furrow in the skin.

Arising from the fascia lata are septa of connective tissue which extend between the individual muscles and groups of muscles; the strongest of these pass behind the origins of the mm. vastus medialis and vastus lateralis to the labium mediale and labium laterale of the linea aspera femoris, forming the *septum intermusculare [femoris] mediale* and *septum intermusculare [femoris] laterale* (see Fig. 438); they serve partly for the attachment of the neighboring muscles.

Bursa trochanterica subcutanea, frequently present, small, just beneath the skin, upon the lateral surface of the trochanter major.

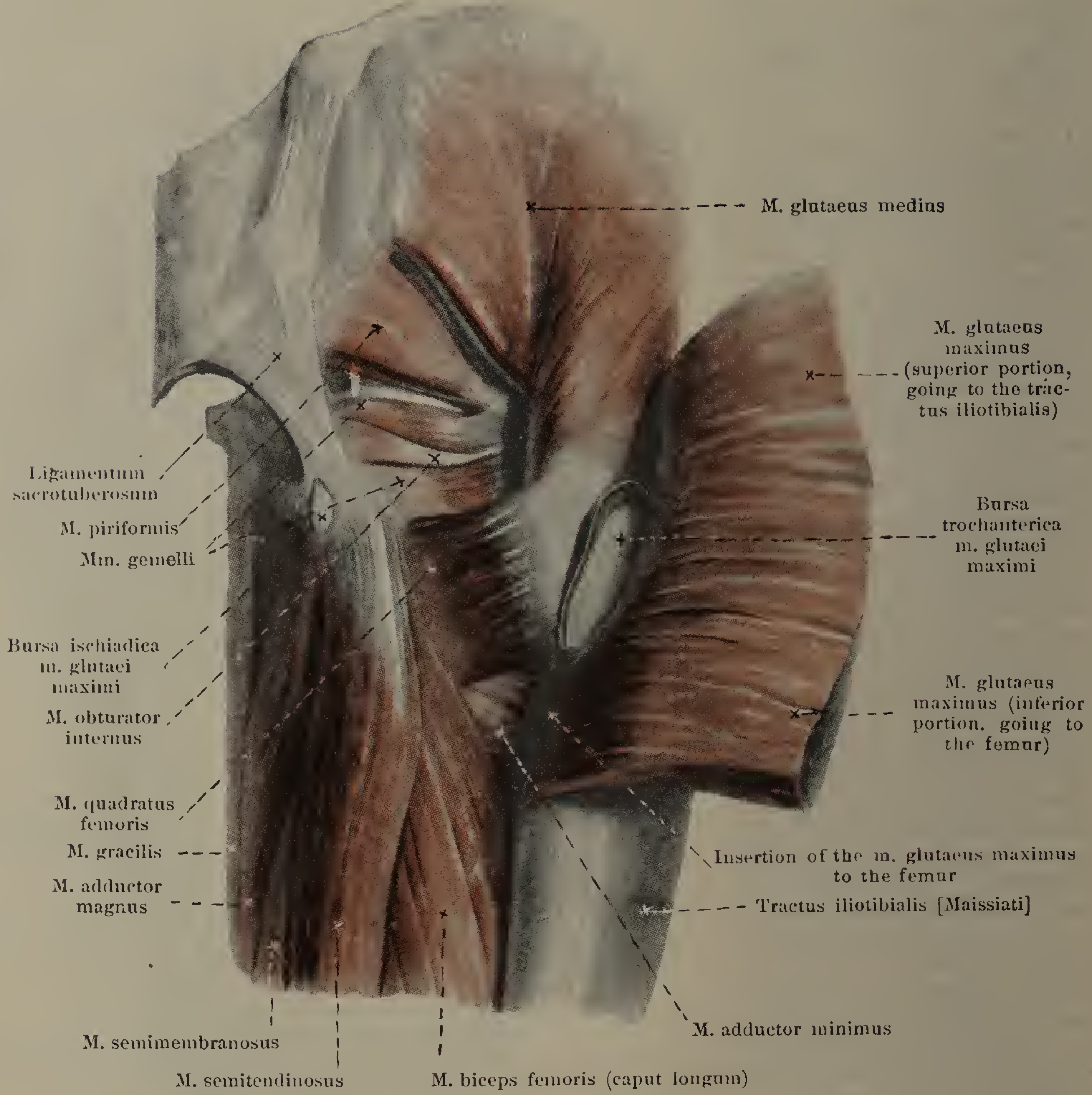
435. Muscles of the right thigh,

viewed from behind.



M. semitendinosus (see also Figs. 436 and 439). Form: triangular, long, tapering below, pinnate; it has in the middle of its dorsal surface an *inscriptio tendinea*. Position: on the posterior surface of the thigh; behind, in large part, superficial, covered only above by the m. glutaeus maximus; lateralward it is bounded by the caput longum m. bicipitis, medianward and in front by the mm. adductor magnus and semimembranosus. Origin: tendinous from the tuber ischiadiacum, in common with the caput longum m. bicipitis *(bursa m. bicipitis femoris superior*, see p. 361). Insertion: it runs converging downward, then lies with a long tendon which begins on the median side in a furrow of the m. semimembranosus and extends from there behind the tendon of the m. gracilis and in common with it, in a curve, forward to the tuberositas tibiae (see m. sartorius p. 349) *(bursa anserina* see p. 351). Action: it extends the thigh backward, adducts it and rotates it somewhat inward; it flexes the leg and rotates it inward. Innervation: n. tibialis (L4, L5, **S1**, S2).

M. semimembranosus (see also Figs. 430, 436, 437 and 439). Form: flat, oblong-quadrangular, pinnate. Position: on the posterior surface of the thigh; below, partly just beneath the skin, otherwise covered by the m. semitendinosus, above also by the m. glutaeus maximus; lateralward below it is bounded by the m. biceps, in front by the mm. quadratus femoris, adductor magnus and gracilis. Origin: by a flat, long, strong tendon from the tuber ischiadicum *(bursa m. bicipitis femoris superior* see p. 361). (Continued on p. 358.)

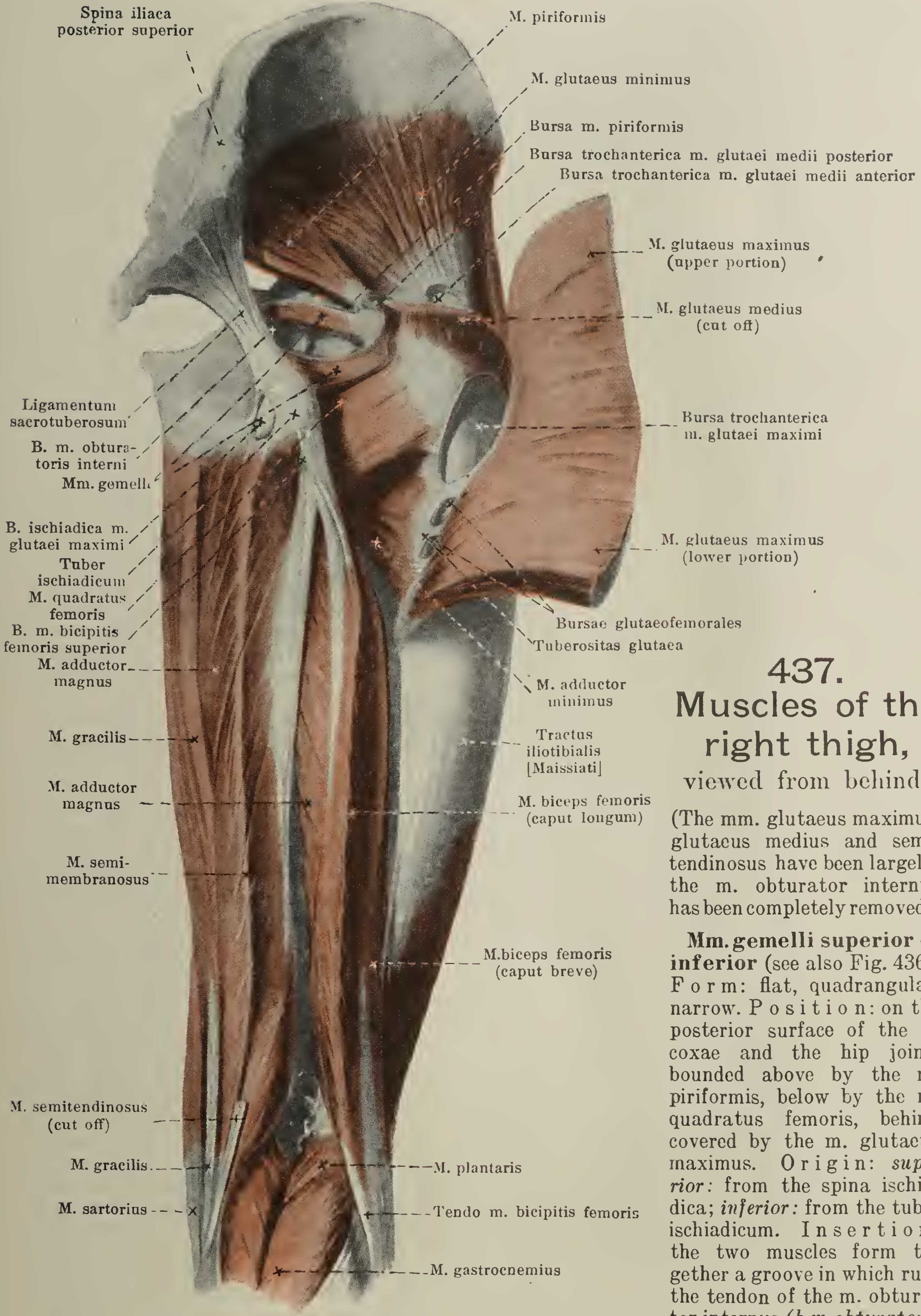

M. glutaeus medius
M. glutaeus maximus (superior portion, going to the tractus iliotibialis)
Bursa trochanterica m. glutaei maximi
M. glutaeus maximus (inferior portion, going to the femur)
Insertion of the m. glutaeus maximus to the femur
Tractus iliotibialis [Maissiati]
M. adductor minimus
Ligamentum sacrotuberosum
M. piriformis
Mm. gemelli
Bursa ischiadica m. glutaei maximi
M. obturator internus
M. quadratus femoris
M. gracilis
M. adductor magnus
M. semimembranosus
M. semitendinosus
M. biceps femoris (caput longum)

436. Muscles of the right buttock (2nd layer), viewed from behind.

(The m. glutaeus maximus has been cut through and reflected lateralward.)

M. semimembranosus (continued). Insertion: the tendon reaches downward on the lateral surface of the muscle as far as its lower half; from its medial surface fibres go medianward and downward to a tendinous strip, which begins in the upper half, runs downward on the medial surface and goes, behind the epicondylus medialis femoris between the tendons of the mm. gracilis and semitendinosus (see Fig. 439), to the condylus medialis tibiae; it is there, partly covered by the ligamentum collaterale tibiale, (bent forward) attached to the bone; in part it bends around into the lig. popliteum obliquum and in part it goes over into that portion of the fascia cruris which covers the posterior surface of the m. popliteus (see Fig. 309) *(bursa m. semimembranosi* see p. 366). Action: it extends the thigh backward, adducts it and and rotates it somewhat inward; it flexes the leg and rotates it inward. Innervation: n. tibialis ([L_4] L_5, S_1).

M. glutaeus medius (see also Figs. 380, 427, 428, 433 and 435). Form: flat, triangular, thick, bipinnate. Position: on the lateral surface of the hip; in its upper and lateral parts superficial, covered only by the fascia lata, which is here very thick; in front it is overlapped by the m. tensor fasciae latae, behind by the m. glutaeus maximus, being bounded medianward by the m. glutaeus minimus and in front very frequently fused with it. Origin: lateral surface of the ala oss. ilium, between the lineae glutaeae anterior and posterior; fascia lata. Insertion: the fibres converge downward and become attached by a short tendon to the lateral surface of the trochanter major, near its apex *(bursae trochantericae m. glutaei medii* see p. 361). Action: it abducts the thigh; the anterior portion flexes it and rotates it somewhat inward, the posterior, larger portion extends it and rotates it somewhat outward. Innervation: n. glutaeus superior (L_4, L_5, S_1 [S_2]).


Spina iliaca posterior superior
M. piriformis
M. glutaeus minimus
Bursa m. piriformis
Bursa trochanterica m. glutaei medii posterior
Bursa trochanterica m. glutaei medii anterior
M. glutaeus maximus (upper portion)
M. glutaeus medius (cut off)
Ligamentum sacrotuberosum
B. m. obturatoris interni
Mm. gemelli
Bursa trochanterica m. glutaei maximi
B. ischiadica m. glutaei maximi
Tuber ischiadicum
M. quadratus femoris
B. m. bicipitis femoris superior
M. glutaeus maximus (lower portion)
Bursae glutaeofemorales
Tuberositas glutaea
M. adductor magnus
M. adductor minimus
M. gracilis
Tractus iliotibialis [Maissiati]
M. adductor magnus
M. biceps femoris (caput longum)
M. semimembranosus
M.biceps femoris (caput breve)
M. semitendinosus (cut off)
M. gracilis
M. plantaris
M. sartorius
Tendo m. bicipitis femoris
M. gastrocnemius

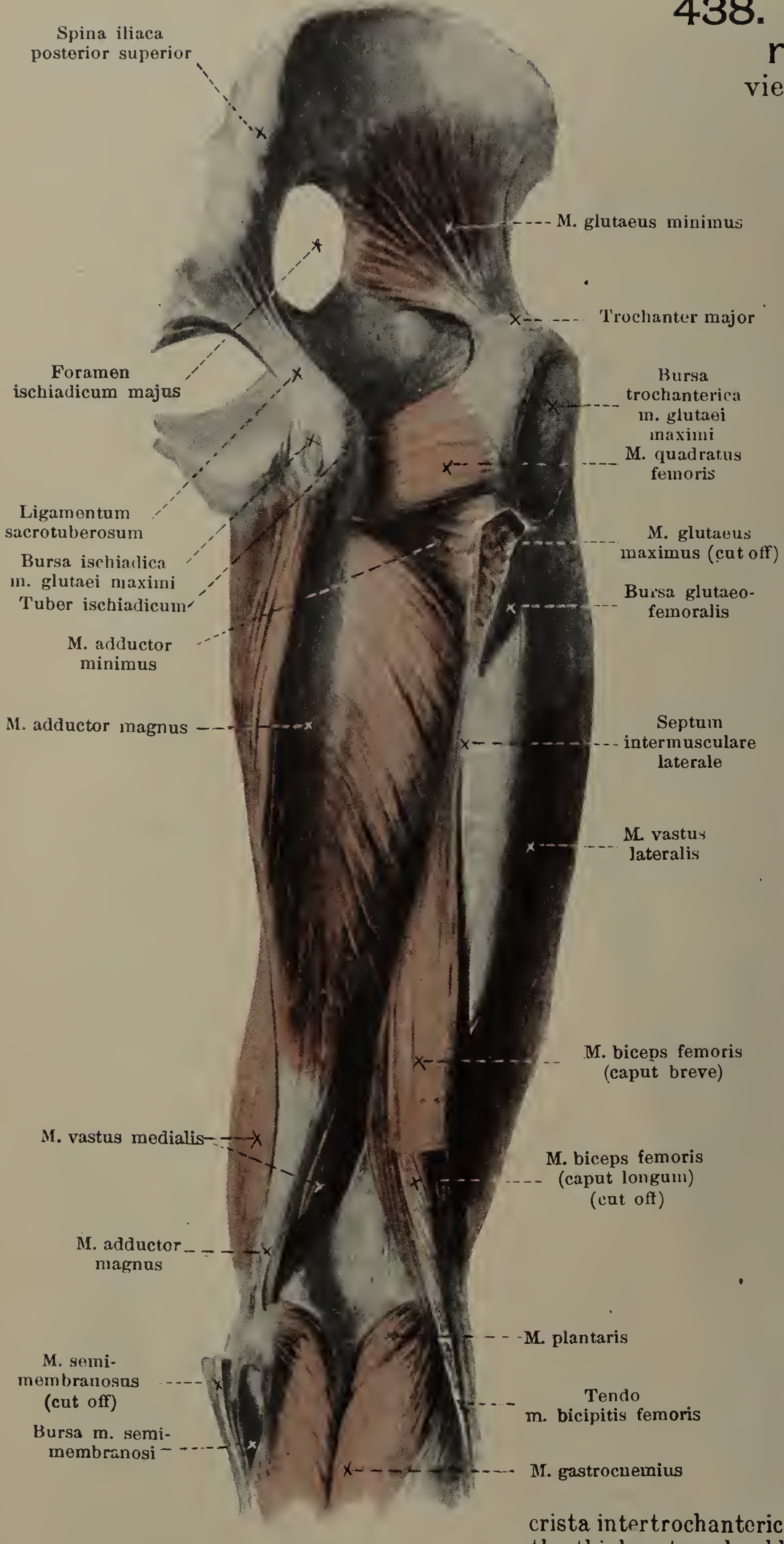
437.
Muscles of the right thigh,
viewed from behind.

(The mm. glutaeus maximus, glutaeus medius and semitendinosus have been largely, the m. obturator internus has been completely removed.)

Mm. gemelli superior et inferior (see also Fig. 436). Form: flat, quadrangular, narrow. Position: on the posterior surface of the os coxae and the hip joint, bounded above by the m. piriformis, below by the m. quadratus femoris, behind covered by the m. glutaeus maximus. Origin: *superior:* from the spina ischiadica; *inferior:* from the tuber ischiadicum. Insertion: the two muscles form together a groove in which runs the tendon of the m. obturator internus (*b.m.obturatoris interni* see p. 361); the fibres run, parallel, lateralward mostly to the tendon of the m. obturator internus, partly beside this to the fossa trochanterica femoris. Action: they rotate the thigh outward, adduct it and extend it slightly. Innervation: rami musculares of the plexus sacralis (superior: L_5, **S_1**, S_2 [S_3]; inferior: L_4, **L_5**, S_1).

438. Muscles of the right thigh,

viewed from behind.

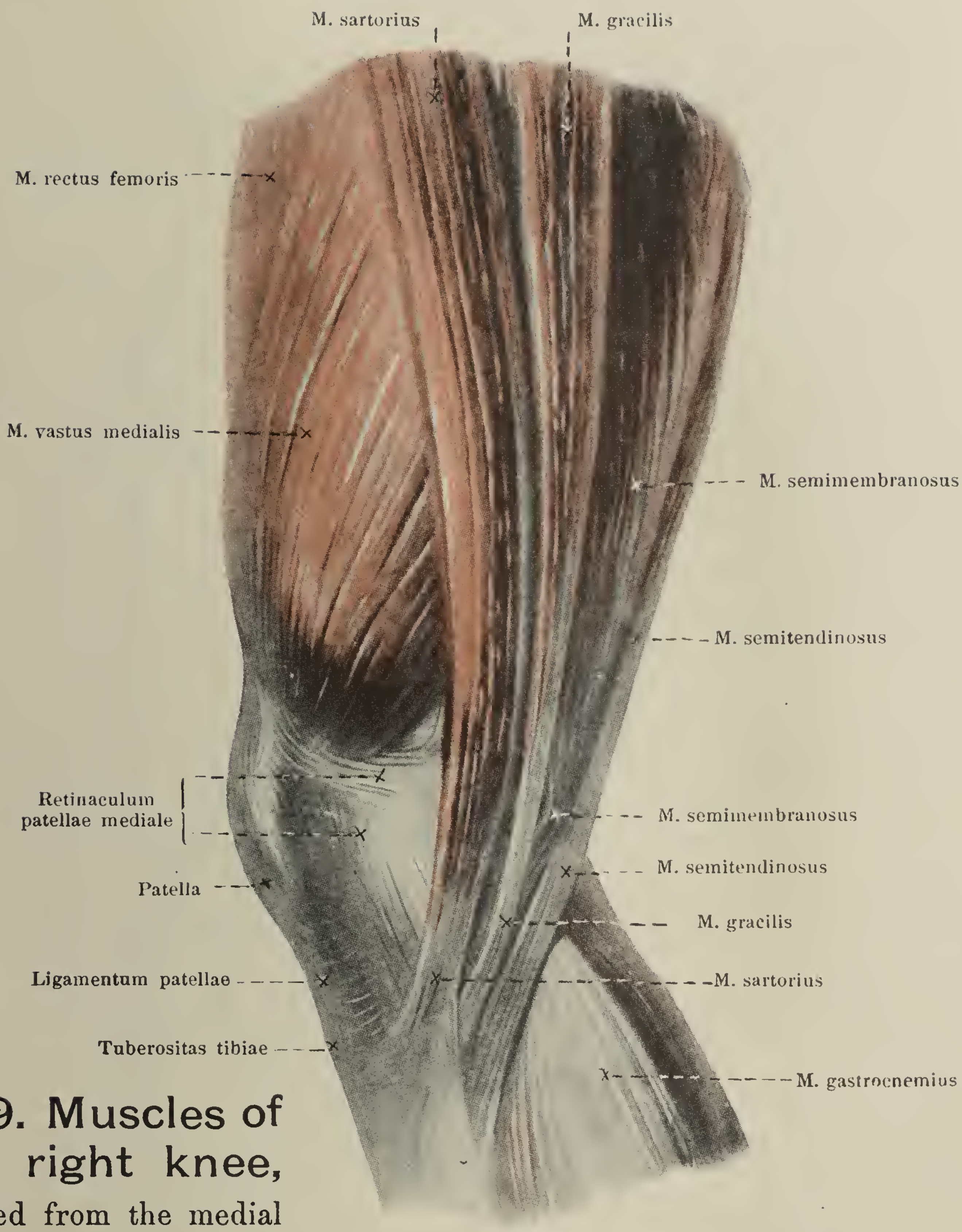

Spina iliaca posterior superior
Foramen ischiadicum majus
Ligamentum sacrotuberosum
Bursa ischiadica m. glutaei maximi
Tuber ischiadicum
M. adductor minimus
M. adductor magnus
M. vastus medialis
M. adductor magnus
M. semimembranosus (cut off)
Bursa m. semimembranosi
M. glutaeus minimus
Trochanter major
Bursa trochanterica m. glutaei maximi
M. quadratus femoris
M. glutaeus maximus (cut off)
Bursa glutaeofemoralis
Septum intermusculare laterale
M. vastus lateralis
M. biceps femoris (caput breve)
M. biceps femoris (caput longum) (cut off)
M. plantaris
Tendo m. bicipitis femoris
M. gastrocnemius

(The mm. glutaei maximus et medius, piriformis, obturator internus, gemelli, semitendinosus and semimembranosus, as well as the caput longum m. bicipitis, have been removed.)

M. glutaeus minimus (see also Figs. 431 and 437). Form: flat, triangular. Position: on the lateral surface of the hip, just above the hip-joint partly on the capsule of same; covered by the m. glutaeus medius, in front partly fused with it; bounded in front by the mm. rectus femoris and tensor fasciae latae, behind by the m. piriformis. Origin: lateral surface of the ala oss. ilium between the lineae glutaeae anterior and inferior. Insertion: the fibres converge downward, lateralward and forward, go with a strong tendon to the anterior surface of the trochanter major femoris (*b. trochanterica m. glutaei minimi* see p. 353). Action: it abducts the thigh, the much larger anterior portion flexes and rotates it somewhat inward, the posterior portion extends it and rotates it somewhat outward. Innervation: n. glutaeus superior(L_4, L_5, S_1 [S_2]).

M. quadratus femoris (see also Figs. 430, 436 and 437). Form: flat, quadrangular. Position: behind and below the hip-joint, bounded in front by the m. obturator externus, below by the m. adductor minimus, behind by the mm. semimembranosus, biceps and glutaeus maximus, above by the m. gemellus inferior. Origin: tuber ischiadicum. Insertion: the fibres run parallel lateralward to the crista intertrochanterica femoris. Action: it rotates the thigh outward, adducts it and flexes it somewhat from the extended position; it draws the flexed leg downward. Innervation: rami musculares of the plexus sacralis (L_4, L_5, S_1).

Bursa ischiadica m. glutaei maximi (see also Figs. 436 and 437), very frequently present, upon the posterior surface of the tuber ischiadicum and of the origins of the mm. biceps and semitendinosus, between these and the m. glutaeus maximus.



439. Muscles of the right knee, viewed from the medial surface.

Bursa trochanterica m. glutaei maximi (see Figs. 436—438,), constant, very large, upon the posterior and lateral surface of the trochanter major as well as upon the origin of the m. vastus lateralis, between these and the upper portion of the m. glutaeus maximus.

Bursae glutaeofemorales (see Figs. 437 and 438), constant, two or three small bursae below the preceding; partly lateral, partly medial from the attachment of the m. glutaeus maximus to the femur.

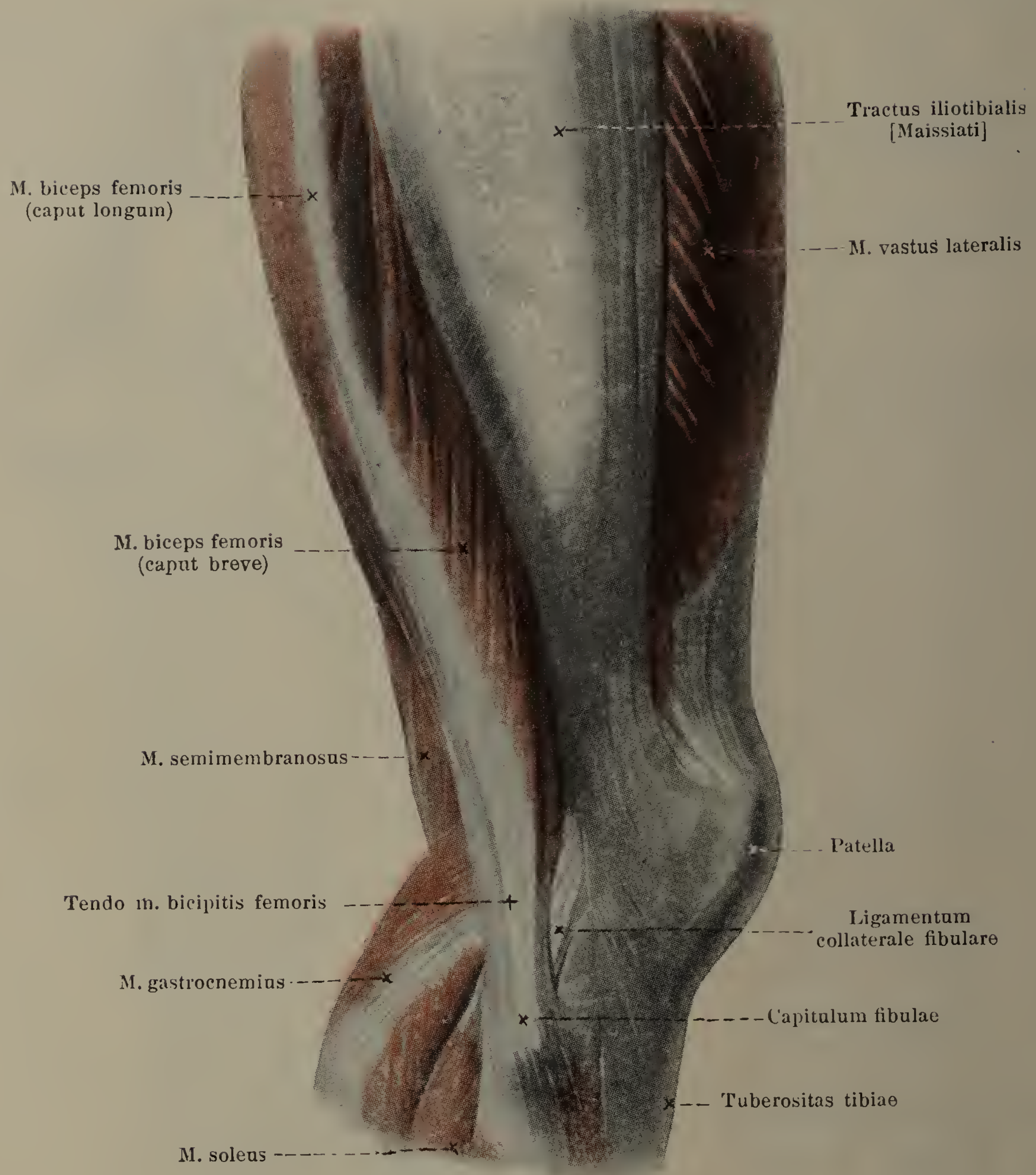
Bursa trochanterica m. glutaei medii anterior (see Fig. 437), constant, sometimes double; between the tendon of the m. glutaeus medius and the apex of the trochanter major.

Bursa trochanterica m. glutaei medii posterior (see Fig. 437), very frequently present, between the tendon of the m. glutaeus medius and the tendon of the m. piriformis.

Bursa m. piriformis (see Fig. 437), frequently present, in front of and below the tendon of the m. piriformis, between it, the bone and the m. gemellus superior.

Bursa m. obturatoris interni (see Fig. 437), constant, between the incisura ischiadica minor and the m. obturator internus; it is very often continued into the groove formed by the mm. gemelli, for which it forms a lining; the latter part is very rarely independent.

Bursa m. bicipitis femoris superior (see Fig. 437), inconstant, between the tendons of the mm. biceps and semitendinosus on the one hand and the tendon of the m. semimembranosus on the other.


Tractus iliotibialis [Maissiati]
M. biceps femoris (caput longum)
M. vastus lateralis
M. biceps femoris (caput breve)
M. semimembranosus
Patella
Tendo m. bicipitis femoris
Ligamentum collaterale fibulare
M. gastrocnemius
Capitulum fibulae
Tuberositas tibiae
M. soleus

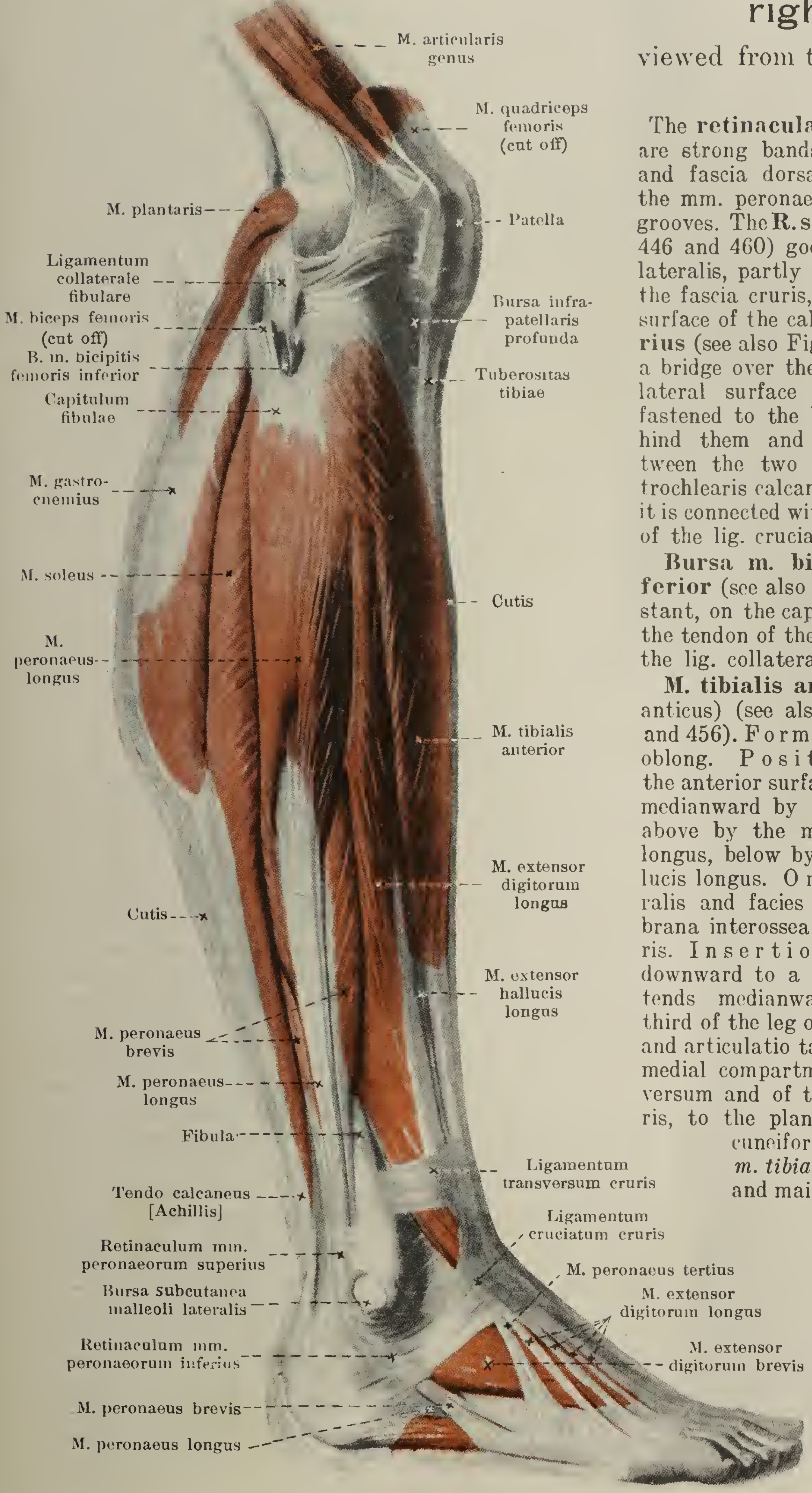
440. Muscles of the right knee,
viewed from the lateral surface.

(The fascia lata with the exception of the tractus iliotibialis has been removed.)

M. biceps femoris (see also Figs. 435—438). Form: triangular-prismatic, long, with two heads. Position: on the posterior surface of the thigh, chiefly superficial, covered only above by the m. glutaeus maximus; bounded medianward by the mm. semitendinosus and semimembranosus, lateralward by the m. vastus lateralis, in front by the mm. quadratus femoris and adductor magnus. Origin: *caput longum:* by a short, strong tendon from the tuber ischiadicum, in common with the m. semitendinosus *(bursa m. bicipitis femoris superior* see p. 361); the tendon is continued on the medial surface of the muscle as far as its inferior half; from it muscle fibres run out lateralward and downward to a tendon which begins on the lateral surface in the upper half of the muscle; *caput breve:* fleshy, from the labium laterale of the linea aspera femoris; the fibres go backward and downward to the tendon of the caput longum. Insertion: the lowermost, common part extends downward behind the epicondylus lateralis femoris *(b. bicipitogastrocnemialis* see p. 366) and goes by a strong, rounded tendon to the capitulum fibulae; in so doing it spans the lig. collaterale fibulare from behind and lateralward by two limbs *(bursa m. bicipitis femoris inferior* see p. 363). Action: it extends the thigh backward, adducts it and rotates it outward; it flexes the leg and rotates it outward. Innervation: *caput longum:* n. tibialis ([L5] S1, **S2**, S3): *caput breve:* n. peronaeus communis (L_4, L_5, S_1).

441. Muscles of the right leg,

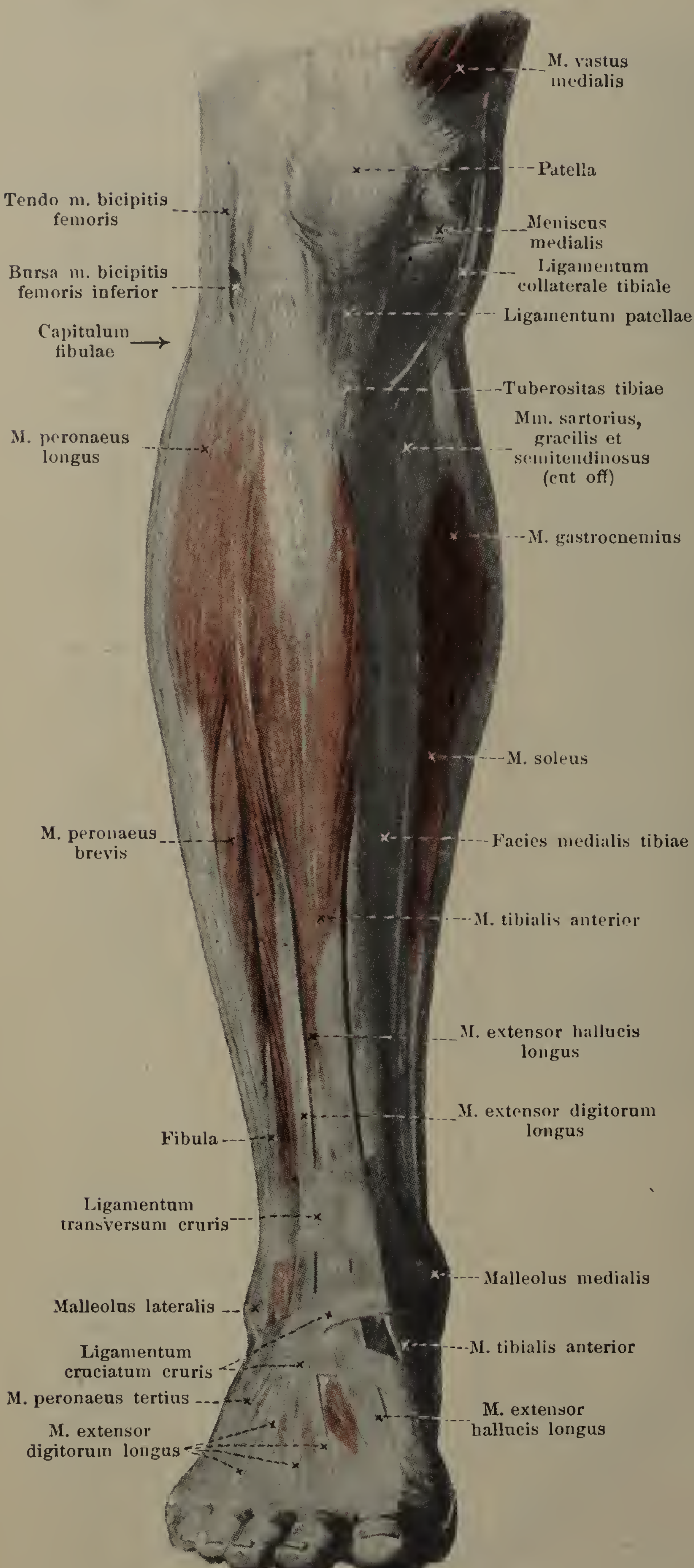
viewed from the lateral surface.


M. articularis genus
M. quadriceps femoris (cut off)
M. plantaris
Patella
Ligamentum collaterale fibulare
Bursa infrapatellaris profunda
M. biceps femoris (cut off)
B. m. bicipitis femoris inferior
Tuberositas tibiae
Capitulum fibulae
M. gastrocnemius
M. soleus
Cutis
M. peronaeus longus
M. tibialis anterior
M. extensor digitorum longus
Cutis
M. extensor hallucis longus
M. peronaeus brevis
M. peronaeus longus
Fibula
Ligamentum transversum cruris
Tendo calcaneus [Achillis]
Ligamentum cruciatum cruris
Retinaculum mm. peronaeorum superius
M. peronaeus tertius
Bursa subcutanea malleoli lateralis
M. extensor digitorum longus
Retinaculum mm. peronaeorum inferius
M. extensor digitorum brevis
M. peronaeus brevis
M. peronaeus longus

The **retinacula mm. peronaeorum** are strong bands of the fascia cruris and fascia dorsalis pedis which hold the mm. peronaei firmly in their bony grooves. The **R. superius** (see Figs. 444, 446 and 460) goes, from the malleolus lateralis, partly into the deep layer of the fascia cruris, partly to the lateral surface of the calcaneus. The **R. inferius** (see also Figs. 315 and 460) forms a bridge over the mm. peronaei on the lateral surface of the calcaneus, is fastened to the bone in front and behind them and sends a septum between the two tendons to the proc. trochlearis calcanei. At the front above it is connected with the superficial layer of the lig. cruciatum.

Bursa m. bicipitis femoris inferior (see also Fig. 442), almost constant, on the capitulum fibulae between the tendon of the m. biceps femoris and the lig. collaterale fibulare.

M. tibialis anterior (O. T. tibialis anticus) (see also Figs. 442, 452, 453 and 456). Form: triangular-prismatic, oblong. Position: superficial on the anterior surface of the leg; bounded medianward by the tibia, lateralward above by the m. extensor digitorum longus, below by the m. extensor hallucis longus. Origin: condylus lateralis and facies lateralis tibiae, membrana interossea cruris and fascia cruris. Insertion: the fibres converge downward to a flat tendon, which extends medianward, from the lower third of the leg on, in front of the tibia and articulatio talocruralis through the medial compartment of the lig. transversum and of the lig. cruciatum cruris, to the plantar surface of the os cuneiforme I (*b. subtendinea m. tibialis anterioris* see p. 375) and mainly to the plantar surface of the basis oss. metatarsalis I (see also Figs. 319 and 456). Action: it flexes the foot dorsalward and can supinate it somewhat, as well as pronate it a trifle form an intermediate position. Innervation: n. peronaeus profundus ($L_4, L_5 S_1$).


M. vastus medialis
Patella
Tendo m. bicipitis femoris
Meniscus medialis
Bursa m. bicipitis femoris inferior
Ligamentum collaterale tibiale
Ligamentum patellae
Capitulum fibulae
Tuberositas tibiae
M. peronaeus longus
Mm. sartorius, gracilis et semitendinosus (cut off)
M. gastrocnemius
M. soleus
M. peronaeus brevis
Facies medialis tibiae
M. tibialis anterior
M. extensor hallucis longus
M. extensor digitorum longus
Fibula
Ligamentum transversum cruris
Malleolus medialis
Malleolus lateralis
M. tibialis anterior
Ligamentum cruciatum cruris
M. peronaeus tertius
M. extensor hallucis longus
M. extensor digitorum longus

442. Muscles of the right leg,

viewed from in front.

M. extensor digitorum longus (see also Figs. 441, 452 and 453). Form: flat, oblong, pinnate. Position: just beneath the skin, on the lateral surface of the leg; bounded medianward above by the m. tibialis anterior, below by the m. extensor hallucis longus, lateralward above by the m. peronaeus longus, below by the m. peronaeus brevis. Origin: fleshy, from the condylus lateralis tibiae, capitulum and crista anterior fibulae, septum intermusculare [fibulare] anterius, membrana interossea cruris and the inner surface of the fascia cruris. Insertion: the fibres extend downward and forward to a tendon beginning medianward in the middle of the leg, which runs, through the lateral compartment of the lig. transversum and of the lig. cruciatum cruris, forward and downward and becomes subdivided below into five tendons. Of these, the four medial tendons diverge to the heads of the ossa metatarsalia II to V, unite at the base of the first phalanx of the 2nd—4th toe with the corresponding tendons of the m. extensor digitorum brevis, pass forward upon the dorsal surface of the phalanges of the toes, and each becomes attached by a middle process to the second, and by two lateral processes to the third phalanx. Upon the first phalanx each tendon forms, as in the fingers (see p. 330), a triangular expansion, into the lateral processes of which the mm. lumbricales and interossei may be inserted. The fifth tendon, that situated farthest lateralward, and the muscle belonging to it, usually incompletely separated above, namely the **m. peronaeus tertius** (see also Figs. 441, 452 and 460), extends to the dorsal surface, the base of the os metatarsale V. Action: it flexes the foot dorsalward, pronates and abducts it; it draws the 2nd—5th toe somewhat dorsalward. Innervation: nerv. peronaeus profundus (L_4, L_5, S_1).

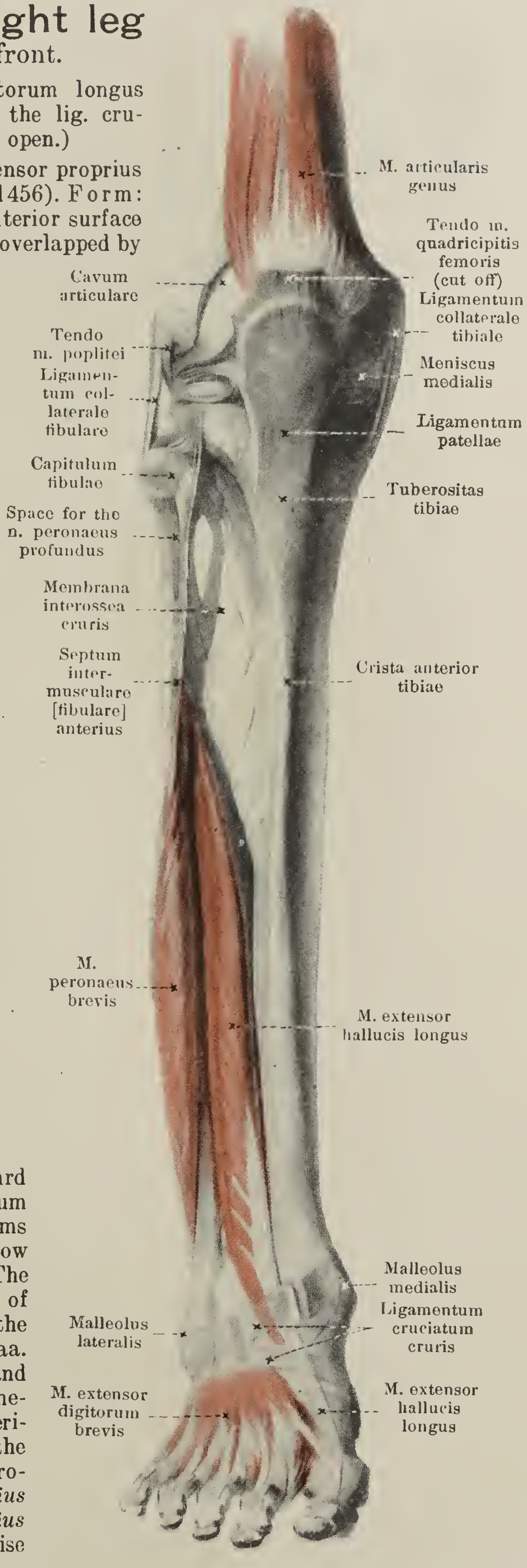
443. Muscles of the right leg

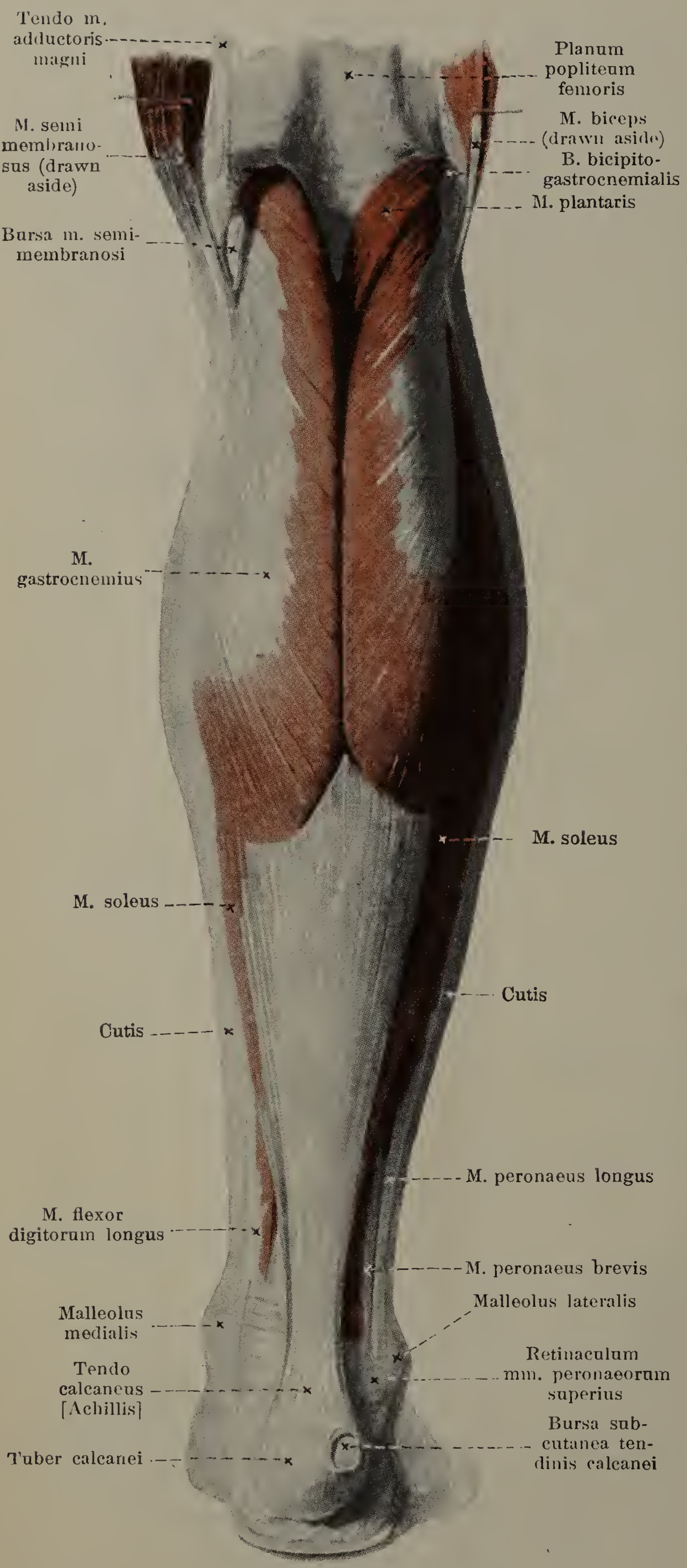
(2nd layer), viewed from in front.

(The mm. tibialis anterior, extensor digitorum longus and peronaeus longus have been removed; the lig. cruciatum cruris has been partially cut open.)

M. extensor hallucis longus (O. T. extensor proprius hallucis) (see also Figs. 441, 442, 452, 453 and 456). Form: flat, oblong, pinnate. Position: on the anterior surface of the leg, below just beneath the skin, above overlapped by its two neighbors; bounded lateralward by the m. extensor digitorum longus, medianward by the m. tibialis anterior. Origin: membrana interossea cruris and facies medialis fibulae. Insertion: the fibres run parallel forward and downward to a flat tendon beginning medianward in the inferior third; this extends, through the lateral compartment of the lig. transversum and through the middle compartment of the lig. cruciatum cruris, forward and medianward on the dorsal surface of the os metatarsale I to the base of the second phalanx of the great toe; with the first phalanx it is connected often by thin bands (see also Fig. 459). Action: it flexes the foot dorsalward, pronates and abducts it somewhat; it extends the first toe dorsalward. Innervation: n. peronaeus profundus (L_4, L_5, S_1).

The **fascia cruris** (see also p. 363 and Figs. 875 and 880) covers ***in the front*** the free surface of the mm. tibialis anterior, extensores and peronaei. It is connected at the knee with the fascia lata, is stronger above than below and, near the ankle-joint, is strengthened by a broad band of transverse fibres, the ***ligamentum transversum cruris*** (O. T. broad part of anterior annular ligament) (see Figs. 442, 452 and 453). This band sharply limited generally only below, is attached at its ends to the fibula and tibia and is divided, by a septum going to the tibia, into two compartments: one medial for the m. tibialis anterior; one lateral for the mm. extensor hallucis longus and extensor digitorum longus; the lower margin of the ligament is connected medianward with the upper medial limb of the lig. cruciatum cruris. ***On the back*** of the leg the fascia forms a superficial and a deep layer which unite below behind the two bones (see also p. 378). The superficial layer covers the dorsal surface of the m. triceps surae, the deeper layer covers the mm. flexores longi and tibialis posterior, the aa. and vv. tibiales posteriores and peroneae and the n. tibialis. Medianward, upon the facies medialis tibiae, the fascia is fused with the periosteum. Lateralward it sends a strip to the fibula, in front of and behind the mm. peronaei, ***septum intermusculare [fibulare] anterius*** and ***septum intermusculare [fibulare] posterius*** (see also Fig. 447) from which the muscles arise in part.


M. articularis genus
Tendo m. quadricipitis femoris (cut off)
Cavum articulare
Ligamentum collaterale tibiale
Tendo m. poplitei
Meniscus medialis
Ligamentum collaterale fibulare
Ligamentum patellae
Capitulum fibulae
Tuberositas tibiae
Space for the n. peronaeus profundus
Membrana interossea cruris
Septum intermusculare [fibulare] anterius
Crista anterior tibiae
M. peronaeus brevis
M. extensor hallucis longus
Malleolus medialis
Ligamentum cruciatum cruris
Malleolus lateralis
M. extensor digitorum brevis
M. extensor hallucis longus



444. Muscles of the right leg,

viewed from behind.

M. triceps surae, consists of two muscles, *m. gastrocnemius* and *m. soleus*, which are separated at their origins, but are inserted by means of a common tendon, *tendo calcaneus [Achillis]*, into the middle of the posterior surface of the tuber calcanei *(b. tendinis calcanei [Achillis]* see p. 369).

M. gastrocnemius (see also Figs. 309, 435 and 439—442). Form: flat, long, with two heads. Position: superficial on the back of the leg; it forms the main mass of the calf. Origin: tendinous, from the planum popliteum femoris, fused with the capsule of the joint; *caput laterale:* above the condylus lateralis *(b. m. gastrocnemii lateralis* see p. 368) (it frequently contains a small sesamoid bone, *fabella), caput mediale:* above the condylus medialis *(b. m. gastrocnemii medialis* see p. 367) (it contains very seldom a small sesamoid bone). Insertion: fibres for each head arise also from a tendinous strip lying on the surface; they diverge below to form a broad tendon, which begins high up on the anterior surface of the muscle, becomes narrower and thicker below and goes over into the tendo calcaneus; the two heads converge, from their origins on, downward and are separated below only by a narrow groove; the belly of the medial head extends somewhat farther distalward. Action: it flexes the leg; it flexes the foot plantarward, supinates and adducts it. Innervation: n. tibialis (S_1, S_2).

Bursa m. semimembranosi (see also Figs. 438 and 445), constant, double; one between the m. semimembranosus and caput mediale m. gastrocnemii, in front coming in contact with the capsule of the joint (it may communicate with the joint cavity); the other, between the tendon of the m. semimembranosus and the condylus medialis tibiae (see Fig. 447).

Bursa bicipitogastrocnemialis, very rare, between the tendon of the m. biceps on the one side, the caput laterale m. gastrocnemii and m. plantaris on the other side; it is bounded medianward and behind by the n. peronaeus communis.

Bursa subcutanea calcanea (not illustrated), constant, in the sole of the foot, just beneath the skin on the inferior surface of the tuber calcanei.

Bursa subcutanea tendinis calcanei [Achillis] (see also Fig. 460), frequently present, on the posterior surface of the tuber calcanei.

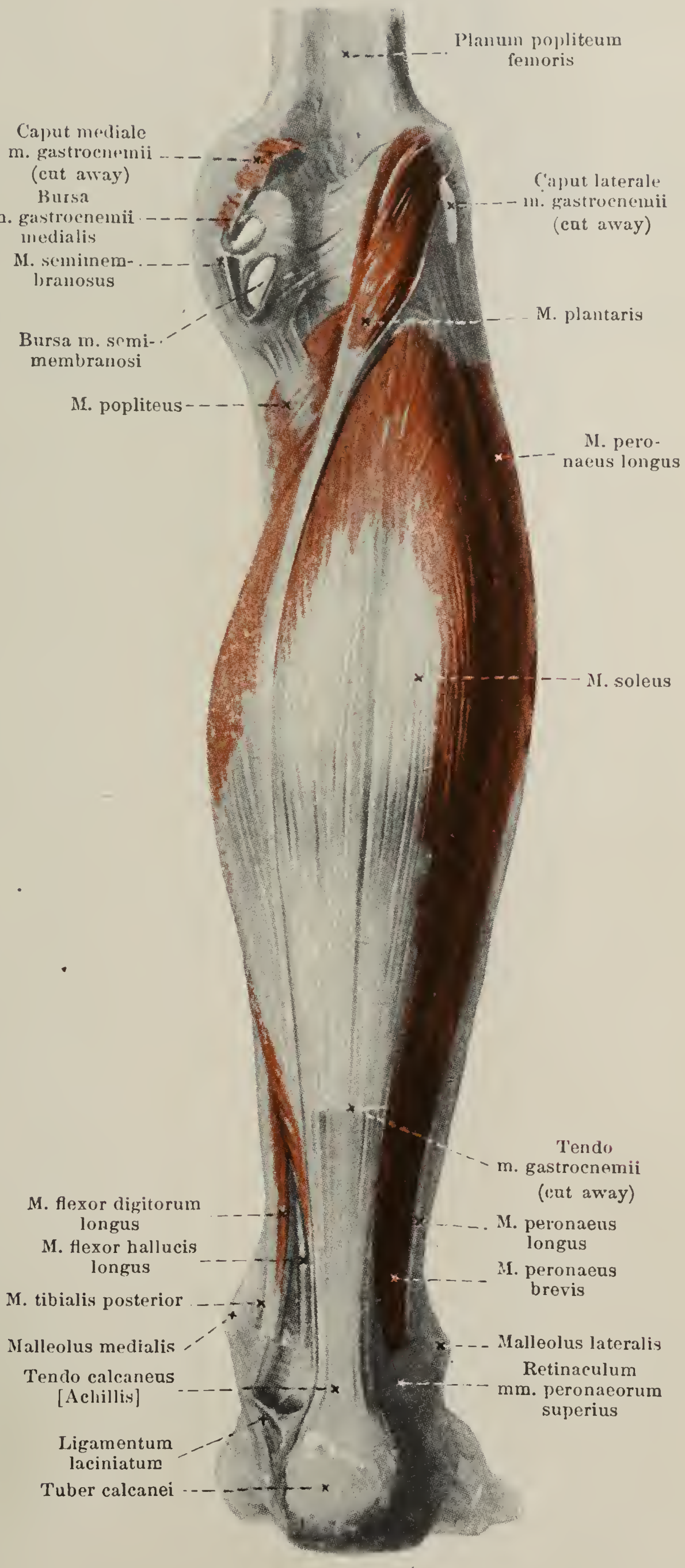
445. Muscles of the right leg (2nd layer), viewed from behind.

(The m. gastrocnemius has been removed.)

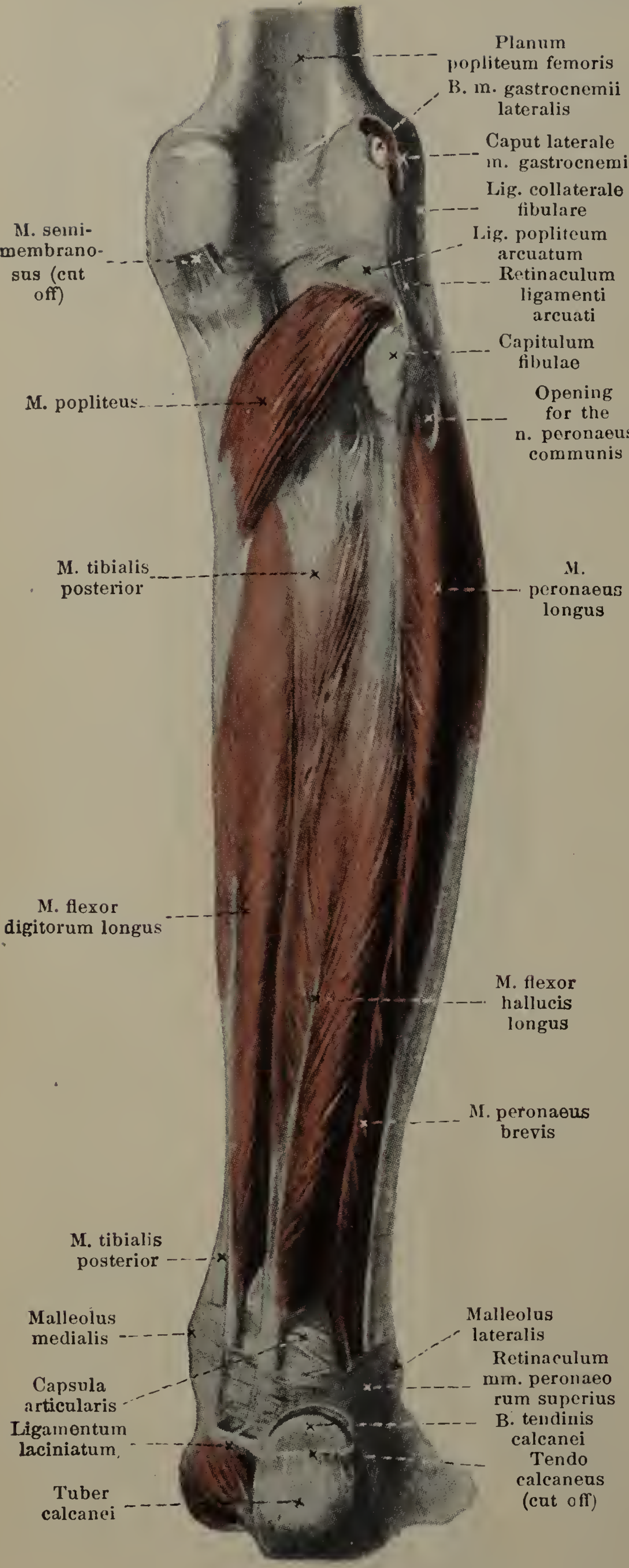
M. soleus (see also Figs. 440 to 442 and 444). Form: flat, spindle-shaped, thick. Position: on the posterior side of the leg, almost completely covered by the m. gastrocnemius, bounded above by the m. popliteus. Origin: from the capitulum and facies posterior fibulae, linea poplitea tibiae and from a tendinous arch between the two. Insertion: backward and downward to a broad superficial tendinous sheet, which becomes narrower and thicker below and goes over into the tendo calcaneus. Action: it flexes the foot plantarward, supinates and adducts it. Innervation: n. tibialis (L_5, S_1, S_2).

M. plantaris (see also Figs. 435, 441 and 444). Form: flat, short, spindle-shaped. Position: on the back of the leg, bounded above lateralward by the caput laterale m. gastrocnemii, in front by the capsule of the joint and the m. popliteus. Origin: planum popliteum femoris above the condylus lateralis, fused with the capsule of the joint. Insertion: medianward and downward to a long, narrow tendon which passes upon the posterior surface of the m. soleus, in front of the m. gastrocnemius, to the medial side of the tendon of the latter and goes over into the tendo calcaneus; in addition some fibres go to the fascia. Action: like the m. gastrocnemius; it makes the fascia tense. Innervation: n. tibialis (L_5, S_1, S_2).

M. popliteus (see also Figs. 309, 312, 443, 446 and 447). Form: flat, triangular. Position: on the back of the knee-joint and of the tibia, covered by the mm. plantaris and gastrocnemius, bounded below by the m. soleus. Origin: by a narrow tendon from the epicondylus lateralis femoris (*b. m. poplitei* see Figg. 312 and 447), in addition by a fleshy origin from the lig. popliteum arcuatum. Insertion: diverging medianward and downward to the facies posterior tibiae. Action: it flexes the leg and rotates it inward. Innervation: n. tibialis (L_4, L_5, S_1).


Planum popliteum femoris
Caput mediale m. gastrocnemii (cut away)
Caput laterale m. gastrocnemii (cut away)
Bursa m. gastrocnemii medialis
M. semimembranosus
M. plantaris
Bursa m. semimembranosi
M. popliteus
M. peronaeus longus
M. soleus
Tendo m. gastrocnemii (cut away)
M. flexor digitorum longus
M. peronaeus longus
M. flexor hallucis longus
M. peronaeus brevis
M. tibialis posterior
Malleolus medialis
Malleolus lateralis
Tendo calcaneus [Achillis]
Retinaculum mm. peronaeorum superius
Ligamentum laciniatum
Tuber calcanei

Bursa m. gastrocnemii medialis, almost constant, between the uppermost part of the capsule of the knee-joint, the femur and the caput mediale m. gastrocnemii; it very frequently communicates with the cavity of the knee-joint.


Planum popliteum femoris
B. m. gastrocnemii lateralis
Caput laterale m. gastrocnemii
Lig. collaterale fibulare
M. semimembranosus (cut off)
Lig. popliteum arcuatum
Retinaculum ligamenti arcuati
Capitulum fibulae
M. popliteus
Opening for the n. peronaeus communis
M. tibialis posterior
M. peronaeus longus
M. flexor digitorum longus
M. flexor hallucis longus
M. peronaeus brevis
M. tibialis posterior
Malleolus medialis
Malleolus lateralis
Retinaculum mm. peronaeorum superius
Capsula articularis
Ligamentum laciniatum
B. tendinis calcanei
Tendo calcaneus (cut off)
Tuber calcanei

446. Muscles of the right leg (3rd layer), viewed from behind.

(The mm. gastrocnemius, plantaris and soleus have been removed.)

M. flexor digitorum longus (see also Figs. 444, 450, 451, 456 and 457). Form: flat, oblong, bipinnate. Position: on the back of the tibia and of the m. tibialis posterior (crossing it obliquely), bounded laterally by the m. flexor hallucis longus and often united with it, covered by the m. soleus. Origin: facies posterior tibiae and the deep layer of the fascia cruris (see p. 365). Insertion: obliquely downward to a tendinous strip, which begins at the medial side of the muscle and goes over above the malleolus into a rounded tendon; this extends, behind and below the tendon of the m. tibialis posterior, on the medial surface of the lig. talotibiale posterius and at the medial margin of the sustentaculum tali of the calcaneus (see p. 155) to the sole of the foot, being held fast by the deep layer of the lig. laciniatum (see also Figs. 319 and 320). It then crosses, plantarward, the tendon of the m. flexor hallucis longus, receives from it a tendinous bundle (seldom gives off a similar bundle) and breaks up into four diverging tendons; these go to the heads of the 2nd—5th os metatarsale, perforate the corresponding tendons of the m. flexor digitorum brevis and always become fastened to the base of the 3rd phalanx. The tendon is covered on the medial border of the foot by the m. abductor hallucis; in the sole plantarward by the m. flexor digitorum brevis. Action: it flexes the foot plantarward, supinates and adducts it; it draws the 3rd phalanx of the 2nd—5th toe plantarward. Innervation: n. tibialis (L_5, S_1).

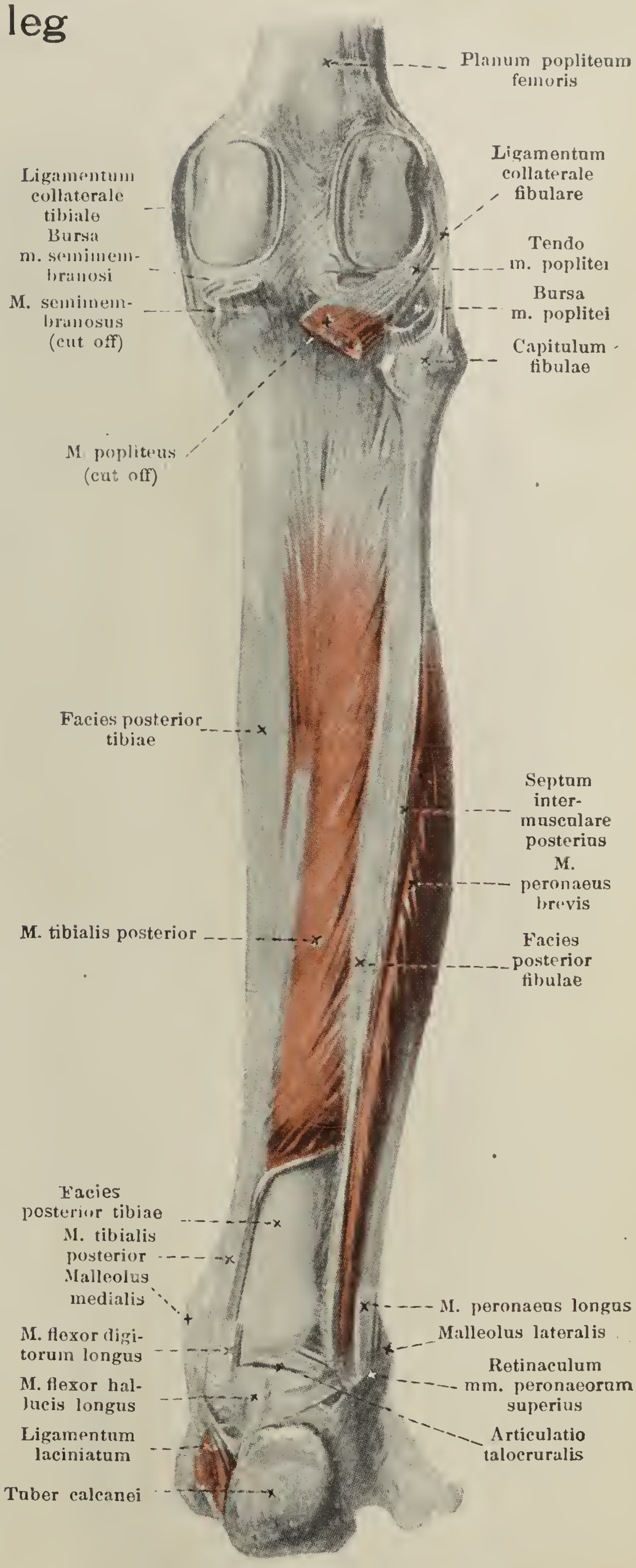
M. flexor hallucis longus (see also Figs. 445, 450, 451 and 456—458). Form: above flat, below rounded, oblong, bipinnate. Position: on the posterior surface of the fibula and of the m. tibialis posterior; it is bounded medianward by the m. flexor digitorum longus (s. above), lateralward by the mm. peronaei, covered by the m. soleus. Origin: facies posterior fibulae, septum intermusculare posterius and the deep layer of the fascia cruris (see p. 365). Insertion: the fibres converge downward to a tendinous strip. Behind the malleolus medialis begins at the medial side of the muscle the rounded tendon, which goes in the sulcus m. flexoris hallucis longi of the talus and calcaneus, held in position by the deep layer of the lig. laciniatum (see also Figs. 319 and 320), behind and under the tendon of the m. flexor digitorum longus, to the sole of the foot. There it crosses dorsalward the tendon of the latter muscle, gives off a process to it (see above), which goes especially to the tendon bundle for the 2nd toe (often also for the 3rd toe) and extends between the bellies of the m. flexor hallucis brevis and the two sesamoid bones to the base of the 2nd phalanx of the 1st toe. At the margin of the foot it is covered by the m. abductor hallucis, in the sole plantarward in part by the m. flexor digitorum brevis. Action: it flexes the foot plantarward, supinates and adducts it; it draws the 1st and 2nd (and 3rd) toe plantarward. Innervation: n. tibialis (L_5, S_1, S_2).

Bursa m. gastrocnemii lateralis, often present, between the uppermost part of the capsule of the knee-joint and the caput laterale m. gastrocnemii; it frequently communicates with the cavity of the joint.

447. Muscles of the right leg

(4th layer), viewed from behind.

(All the muscles have been removed with the exception of the mm. tibialis posterior and peronaeus brevis.)



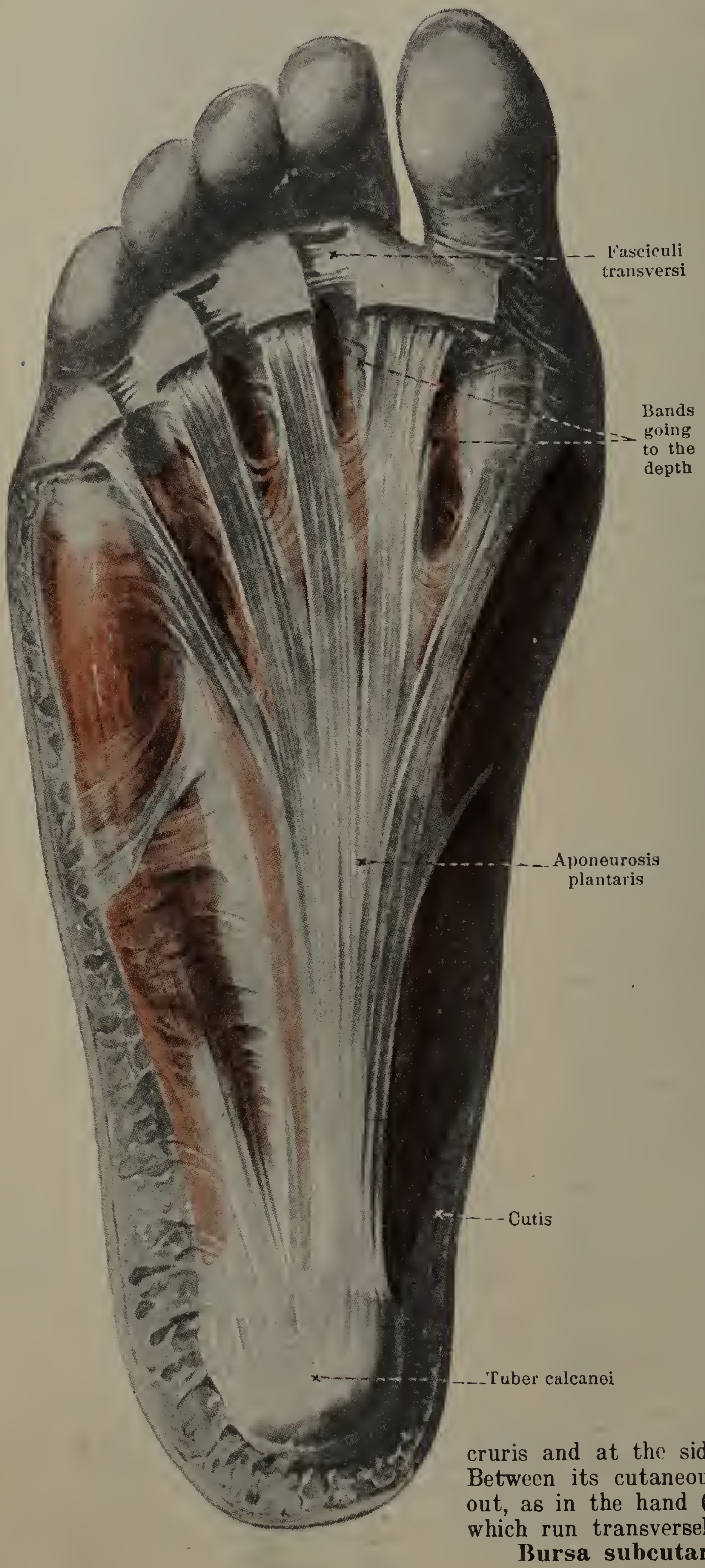
M. tibialis posterior (see also Figs. 446 and 456—458). Form: flat, oblong, penniform. Position: directly upon the posterior surface of the bones of the leg and of the membrana interossea cruris, above between the mm. flexor digitorum longus and flexor hallucis longus, covered below by these, above and below also by the m. soleus. Origin: facies posterior tibiae, membrana interossea cruris and facies medialis fibulae. Insertion: the fibres run obliquely downward to a tendinous strip situated on the medial margin; the round tendon, going out of it above the malleolus medialis, extends directly upon the tibia, in front of the m. flexor digitorum longus, downward and medianward to the sulcus malleolaris tibiae. It is there held in place by the lig. laciniatum, goes in a curve to the medial side of the ligg. talotibiale posterius and calcaneotibiale, thence on the medial and inferior surface of the lig. calcaneonaviculare plantare to the sole of the foot and, lying directly upon the bones and ligaments, it sends strong processes to the tuberositas oss. navicularis (there often a sesamoid cartilage, sometimes a sesamoid bone, see p. 160) and to the os cuneiforme I, and feebler processes to the ossa cuneiformia II and III cuboideum and metatarsalia II, III, IV (see also Figs. 245 and 319). Action: it flexes the foot plantarward, supinates and adducts it. Innervation: n. tibialis (L_5, S_1).

M. peronaeus longus (see Figs. 441, 442, 444—446, 451, 458 and 460). Form: flat, oblong, bipinnate. Position: superficial on the lateral surface of the leg, above upon the fibula, below upon the m. peronaeus brevis; bounded in front by the m. extensor digitorum longus, behind by the m. soleus. Origin: capitulum and facies lateralis fibulae, fascia cruris and septa intermuscularia [fibularia]. Insertion: the fibres go obliquely downward to a tendinous strip; the flat tendon extends above on the lateral, below on the posterior surface of the m. peronaeus brevis downward, then behind and below the malleolus lateralis, upon the lig. calcaneofibulare in a curve to the sulcus m. peronaei [longi] of the calcaneus and is held in place by the retinacula mm. peronaeorum (see p. 363), thence it runs in the sulcus m. peronaei [longi] upon the tuberositas oss. cuboidei to the sole of the foot and there, covered plantarward by the mm. adductor hallucis (caput obliquum) and flexores digitorum as well as by the lig. plantare longum, it goes obliquely forward to the medial border of the foot; it is attached to the os cuneiforme I and tuberositas oss. metatarsalis I (see Fig. 319). In front of the tuberositas oss. cuboidei it often contains a sesamoid cartilage, rarely a sesamoid bone. Action: it flexes the foot plantarward, pronates and abducts it. Innervation: n. peronaeus superficialis (L_4, L_5, S_1).

Bursa m. poplitei (see also Fig. 312) see p. 232.

Bursa tendinis calcanei [Achillis] (see Fig. 446), constantly present, large, between the posterior surface of the tuber calcanei and the tendo calcaneus [Achillis].

448. Fascia of the sole of the right foot.

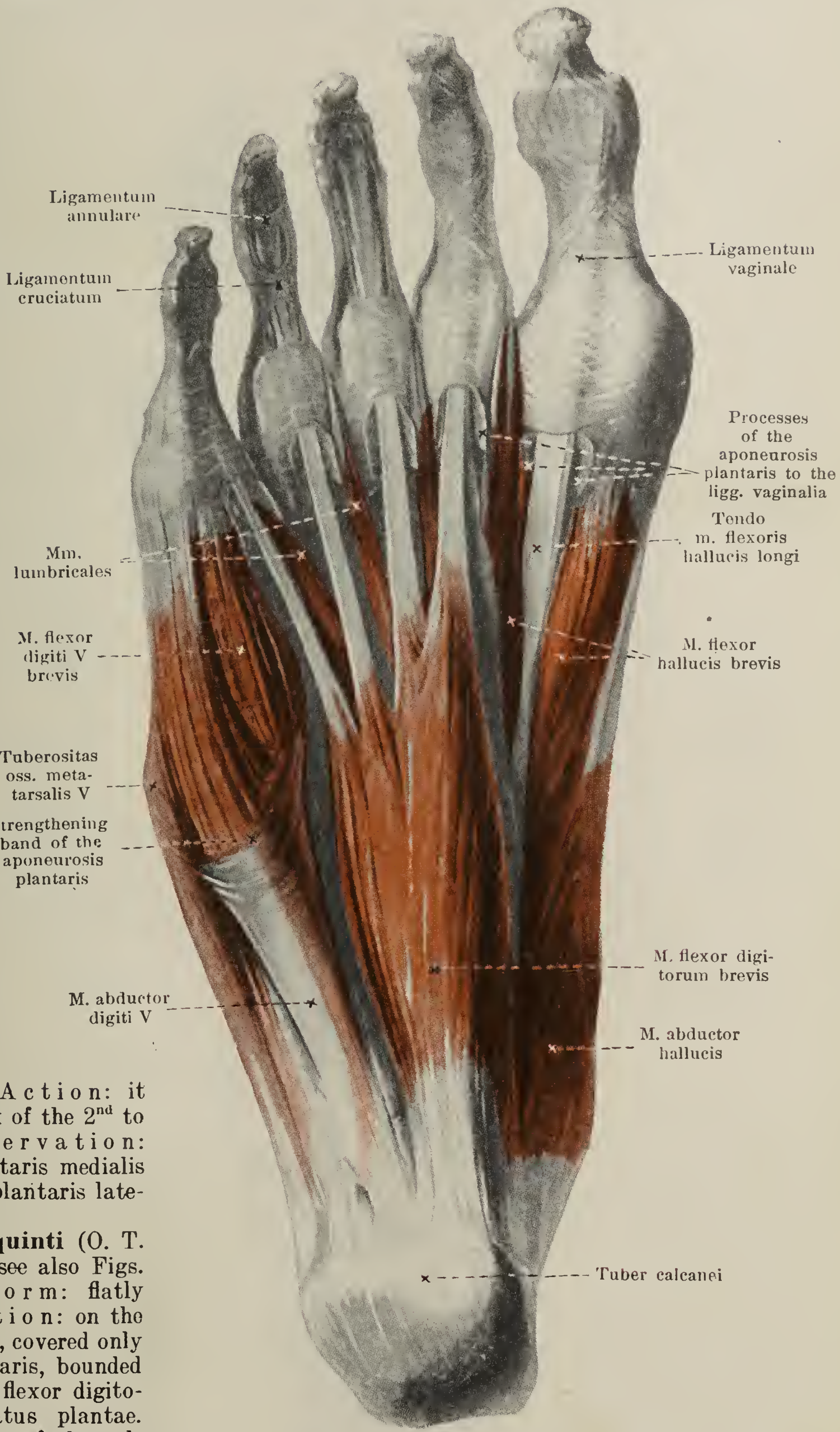


M. peronaeus brevis (see Figs. 441—447, 452, 453 and 460). Form: flat, oblong, bipinnate. Position: on the lateral side of the leg upon the fibula, partly superficial, partly covered by the m. peronaeus longus; bounded in front by the mm. extensor digitorum longus and peronaeus tertius, behind by the m. flexor hallucis longus. Origin: facies lateralis fibulae and septa intermuscularia [fibularia]. Insertion: the fibres converge downward to a tendinous strip; the muscle extends medianward and in front of the tendon of the m. peronaeus longus, in a curve behind and below the malleolus lateralis (in a groove on the same) and then forward, directly upon the lig. calcaneofibulare and above the proc. trochlearis calcanei; it is held in place by the retinacula mm. peronaeorum (see p. 363); thence the rounded tendon goes downward and forward to the tuberositas oss. metatarsalis V; it gives off, usually, also a process to the tendon of the m. extensor digitorum longus going to the little toe (see Fig. 460). Action: it flexes the foot plantarward, pronates and abducts it. Innervation: n. peronaeus superficialis (L_4, L_5, S_1).

The **aponeurosis plantaris** is a thick layer of glistening tendinous fibres just beneath the skin; it covers the inferior surface of the muscles of the sole of the foot. It begins at the tuber calcanei, extends forward, diverging with five processes, and there becomes attached partly to the skin beneath the heads of the ossa metatarsalia, but especially by means of bundles branching off into the depth to go to the ligg. vaginalia. It is strongest in the middle and feebler over the muscles of the great toe and of the little toe; it sends tough septa into the depth near the m. flexor digitorum brevis; otherwise it is connected behind with the fascia cruris and at the sides with the fascia dorsalis pedis. Between its cutaneous insertions, there are stretched out, as in the hand (see p. 335), three bands of fibres which run transversely, the *fasciculi transversi.*

Bursa subcutanea calcanea see p. 366.

449. Muscles of the sole of the right foot.

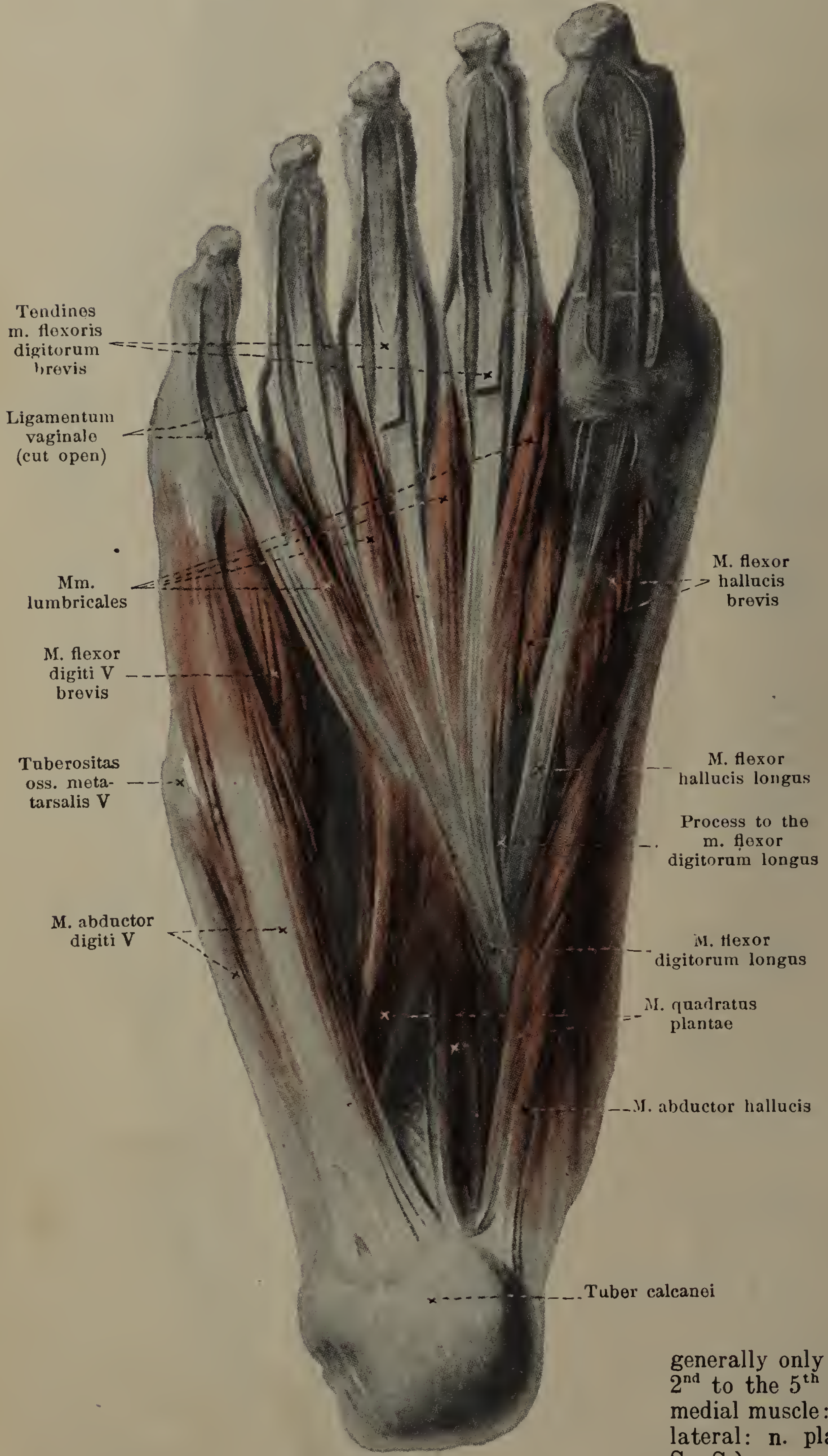

Ligamentum annulare
Ligamentum cruciatum
Ligamentum vaginale
Processes of the aponeurosis plantaris to the ligg. vaginalia
Tendo m. flexoris hallucis longi
Mm. lumbricales
M. flexor digiti V brevis
M. flexor hallucis brevis
Tuberositas oss. metatarsalis V
Strengthening band of the aponeurosis plantaris
M. flexor digitorum brevis
M. abductor digiti V
M. abductor hallucis
Tuber calcanei

M. flexor digitorum brevis (see also Figs. 450 and 451). Form: oblong-quadrangular, thick. Position: in the sole of the foot, covered only by the aponeurosis plantaris; bounded medianward by the m. abductor hallucis, lateralward by the m. abductor digiti V, dorsalward by the m. quadratus plantae and tendo m. flexoris digitorum longi. Origin: processus medialis tuberis calcanei and aponeurosis plantaris. Insertion: the fibres diverge in front into four muscular bellies and flat tendons which go to the 2nd—5th toe; each tendon subdivides at the level of the first phalanx into two processes, permitting the corresponding tendons of the m. flexor digitorum longus to pass through between them, and become attached in the same manner as the corresponding tendons of the hand (see p. 360) to the second phalanx. The muscle belly and the tendon of the 5th toe are usually very weak, and may even be missing. Action: it draws the second phalanx of the 2nd to 5th toe plantarward. Innervation: for 2nd—4th toe: n. plantaris medialis (L_5, S_1); for 5th toe: n. plantaris lateralis (S_1, S_2).

M. abductor digiti quinti (O. T. abductor minimi digiti) (see also Figs. 450, 453 and 460). Form: flatly rounded, oblong. Position: on the lateral margin of the foot, covered only by the aponeurosis plantaris, bounded medianward by the mm. flexor digitorum brevis and quadratus plantae. Origin: inferior surface of the calcaneus, aponeurosis plantaris. Insertion: forward and lateralward partly to the tuberositas oss. metatarsalis V, partly by a half-tendinous insertion to the base of the first phalanx of the 5th toe. Action: it draws the first phalanx of the little toe plantarward and eventually lateralward. Innervation: n. plantaris lateralis (S_1, S_2).

450. Muscles of the sole of the right foot (2nd layer).

(The m. flexor digitorum brevis has been removed down to the tendons.)

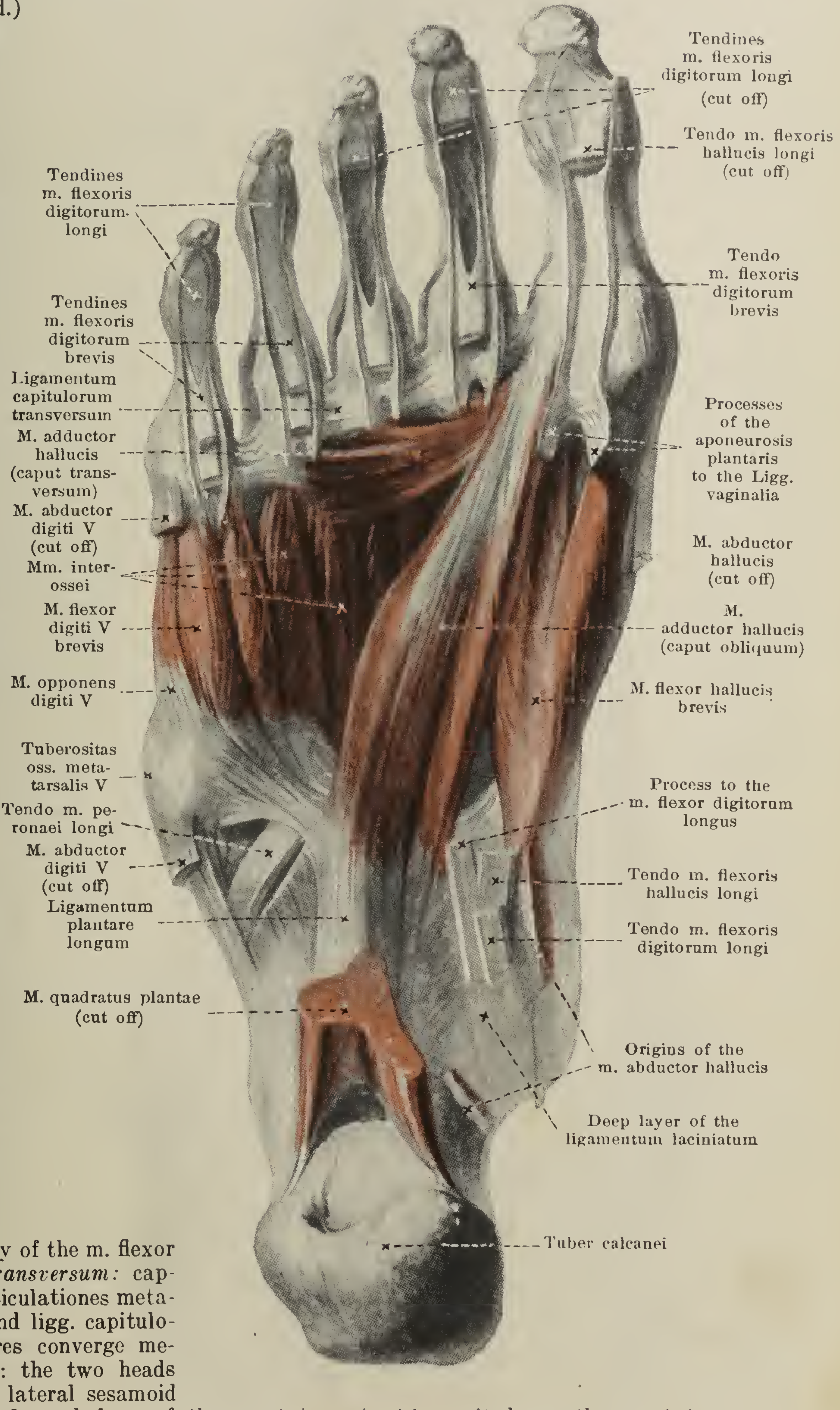

Tendines m. flexoris digitorum brevis
Ligamentum vaginale (cut open)
Mm. lumbricales
M. flexor digiti V brevis
Tuberositas oss. metatarsalis V
M. abductor digiti V
M. flexor hallucis brevis
M. flexor hallucis longus
Process to the m. flexor digitorum longus
M. flexor digitorum longus
M. quadratus plantae
M. abductor hallucis
Tuber calcanei

M. quadratus plantae (O. T. accessorius or flexor accessorius digitorum pedis) (see also Fig. 451). Form: flat, quadrangular. Position: in the sole of the foot, bounded plantarward by the m. flexor digitorum brevis, dorsalward by the lig. plantare longum and caput obliquum m. adductoris hallucis, lateralward by the m. abductor digiti V. Origin: by two processes from the inferior and medial surfaces of the calcaneus. Insertion: forward to the lateral margin of the tendon of the m. flexor digitorum longus. Action: it draws the third phalanx of the 2nd to 5th toe plantarward. Innervation: n. plantaris lateralis (S_1,S_2).

Mm. lumbricales, four. Form: spindle-shaped, narrow. Position: between the terminal tendons of the m. flexor digitorum longus, bounded plantarward by the m. flexor digitorum brevis, dorsalward by the mm. adductor hallucis and interossei. Origin: partly from the medial margin, partly from the opposed margins of the tendons of the m. flexor digitorum longus. Insertion: small tendons extend forward, plantarward from the ligg. capitulorum [oss. metatars.] transversa, to the medial surface of the first phalanx of the 2nd—5th toe and sometimes go over in the triangular expansions of the tendons of the mm. extensores digitorum. Action: they generally only flex the first phalanx of the 2nd to the 5th toe. Innervation: one medial muscle: n. plantaris medialis; three lateral: n. plantaris lateralis (total L_5, S_1, S_2).

451. Muscles of the sole of the right foot (3^{rd} layer).

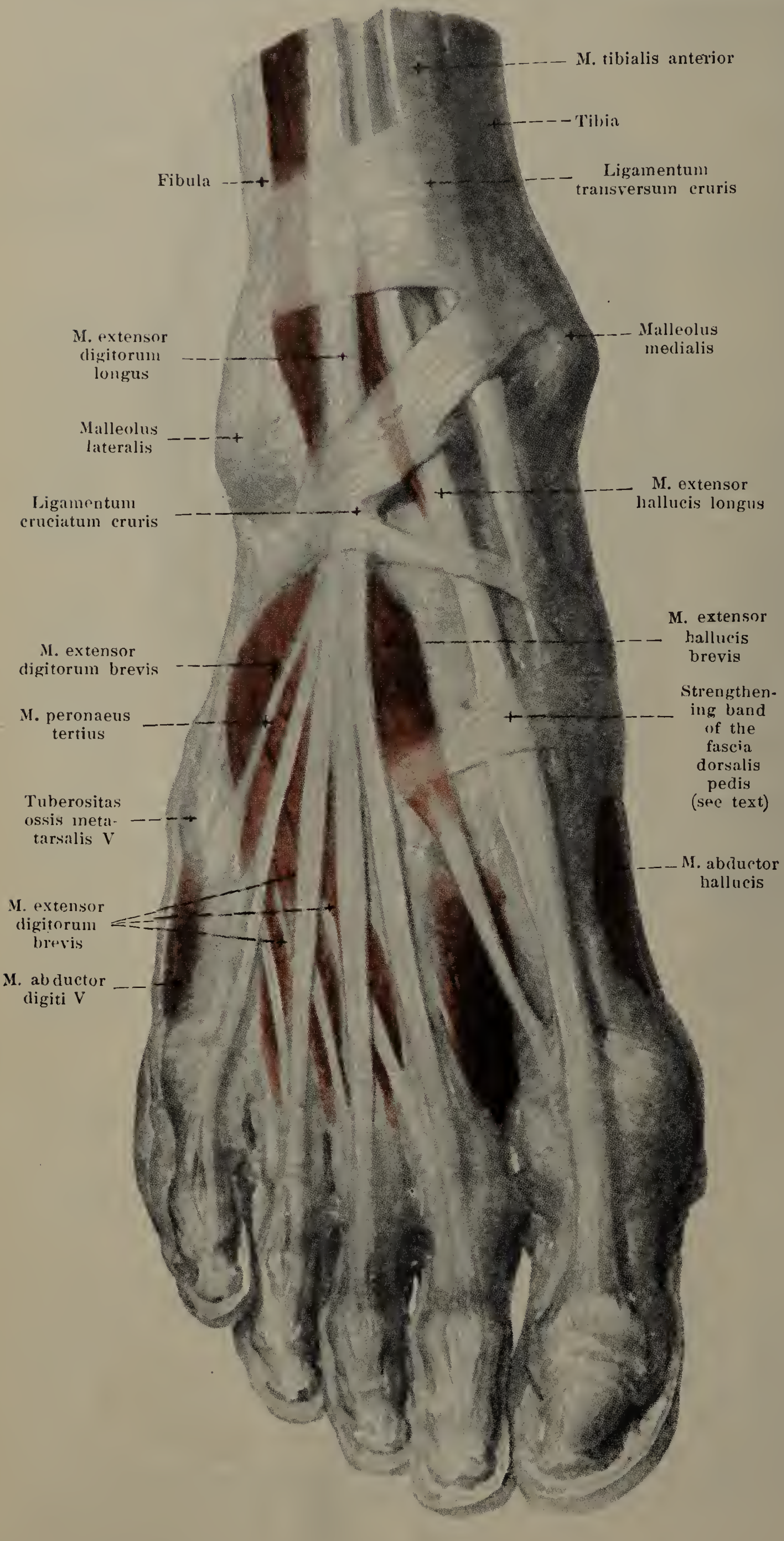
(The m. flexores digitorum, abductor hallucis and adductor digiti V have been removed.)


Tendines m. flexoris digitorum longi
Tendines m. flexoris digitorum brevis
Ligamentum capitulorum transversum
M. adductor hallucis (caput transversum)
M. abductor digiti V (cut off)
Mm. interossei
M. flexor digiti V brevis
M. opponens digiti V
Tuberositas oss. metatarsalis V
Tendo m. peronaei longi
M. abductor digiti V (cut off)
Ligamentum plantare longum
M. quadratus plantae (cut off)
Tendines m. flexoris digitorum longi (cut off)
Tendo m. flexoris hallucis longi (cut off)
Tendo m. flexoris digitorum brevis
Processes of the aponeurosis plantaris to the Ligg. vaginalia
M. abductor hallucis (cut off)
M. adductor hallucis (caput obliquum)
M. flexor hallucis brevis
Process to the m. flexor digitorum longus
Tendo m. flexoris hallucis longi
Tendo m. flexoris digitorum longi
Origins of the m. abductor hallucis
Deep layer of the ligamentum laciniatum
Tuber calcanei

M. flexor hallucis brevis (see also Figs. 449, 450 and 455). Form: oblong. Position: in the sole of the foot, partly superficial, behind and medianward covered by the m. abductor hallucis, lateralward partly fused with the caput obliquum m. adductoris hallucis. Origin: plantar surface of the ossa cuneiformia I—III, os naviculare and lig. calcaneocuboideum plantare. Insertion: it forms two diverging rounded bellies which, becoming tendinous, run to the two sesamoid bones and to the base of the first phalanx of the great toe; in a groove between the two bellies lies the tendon of the m. flexor hallucis longus. Action: it draws the great toe plantarward. Innervation: n. plantaris medialis, seldom also n. plantaris lateralis (total L_5, S_1, S_2).

M. adductor hallucis (see also Fig. 455). Form: two heads. Position: in the sole of the foot, bounded dorsalward by the mm. interossei, plantarward by the mm. flexor digitorum longus and lumbricales. Origin: *caput obliquum:* bases of the ossa metatarsalia II—IV, os cuneiforme III, os cuboideum and lig. plantare longum; the fibres converge to a rounded belly, which is fused medianward with the lateral belly of the m. flexor hallucis brevis; *caput transversum:* capsular ligaments of the articulationes metatarsophalangeae II—V and ligg. capitulorum transversa; the fibres converge medianward. Insertion: the two heads become inserted into the lateral sesamoid bone and the base of the first phalanx of the great toe. Action: it draws the great toe plantarward and lateralward. Innervation: n. plantaris lateralis (S_1, S_2).

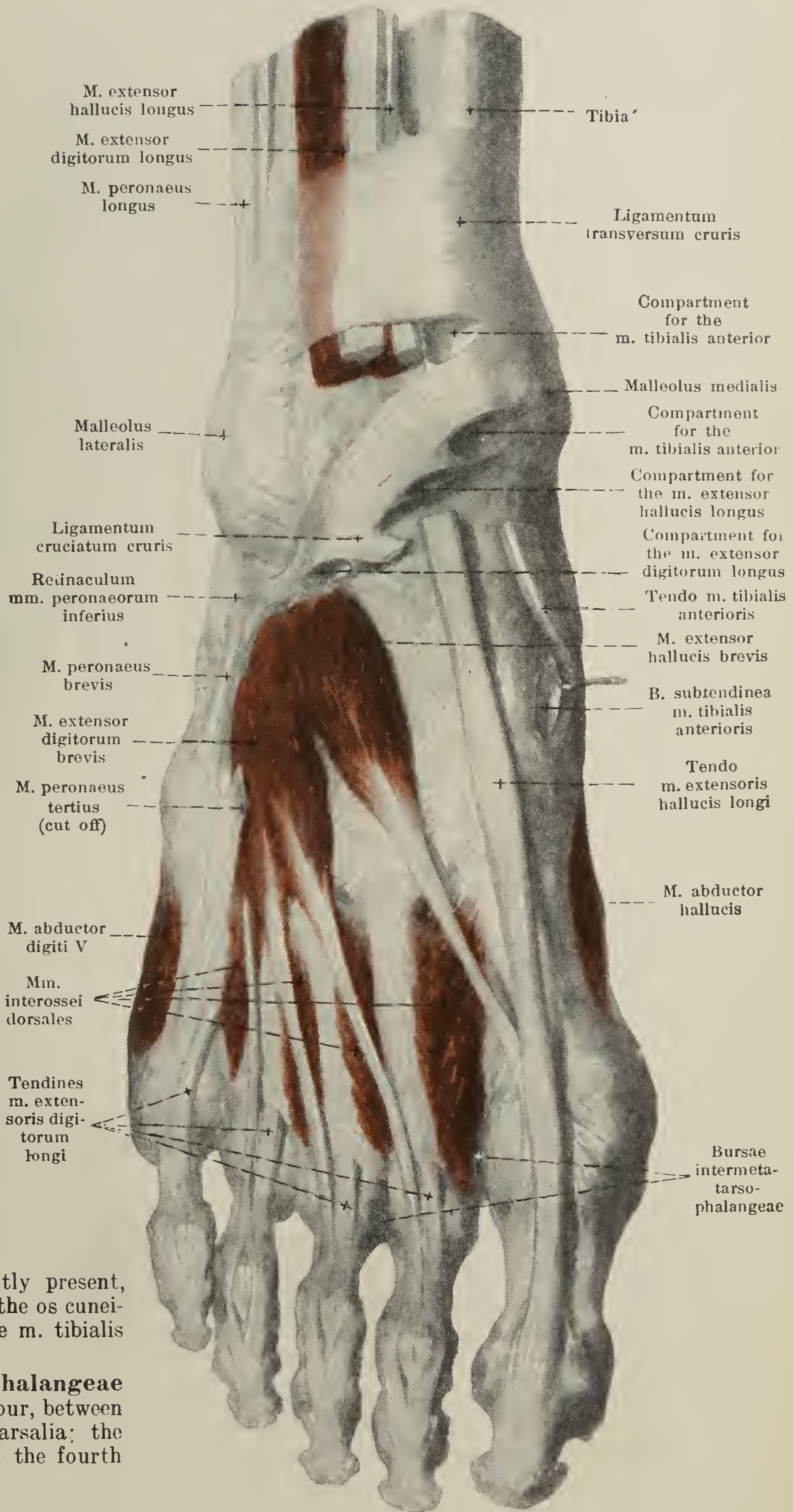
452. Muscles of the back of the right foot.


M. tibialis anterior
Tibia
Fibula
Ligamentum transversum cruris
M. extensor digitorum longus
Malleolus medialis
Malleolus lateralis
M. extensor hallucis longus
Ligamentum cruciatum cruris
M. extensor hallucis brevis
M. extensor digitorum brevis
M. peronaeus tertius
Strengthening band of the fascia dorsalis pedis (see text)
Tuberositas ossis metatarsalis V
M. abductor hallucis
M. extensor digitorum brevis
M. abductor digiti V

The **fascia dorsalis pedis** (see also p. 363) is stretched out in the form of a membrane, for the most part thin, over the tendons and the muscles of the back of the foot; above it is connected with the fascia cruris, at the sides with the aponeurosis plantaris. Interwoven in it, at the junction of the foot with the leg, is situated the powerful *ligamentum cruciatum cruris* (O. T. lower part of anterior annular ligament) (see also Figs. 443, 453, 456 and 460). This usually has the shape of a Y. Its lateral, strongest limb consists of two layers, of which the more superficial arises on the lateral surface of the calcaneus (connected with the retinaculum mm. peronaeorum inferius), the deep one arising in the sinus tarsi; both extend medianward, the former in front of, the latter behind the tendons of the m. extensor digitorum longus and unite on the medial side of the same, then bifurcates into two medial limbs. The inferior medial, more delicate, limb runs in front of the tendons of the mm. extensor hallucis longus and tibialis anterior to the os naviculare and os cuneiforme I (see also Fig. 456). The superior medial, stronger limb goes to the anterior surface of the malleolus medialis (see also: fascia cruris p. 365); it consists likewise of two layers, which run in front of and behind the mm. extensor hallucis longus and tibialis anterior; the main mass of fibres usually runs in front of the m. extensor hallucis longus and behind the m. tibialis anterior. Going off from the medial surface of the os cuneiforme I and os metatarsale I is a curved strengthening band of fibres which passes in front of the mm. tibialis anterior and extensores hallucis to the basis oss. metatarsalis II.

453. Muscles of the back of the right foot (2nd layer).

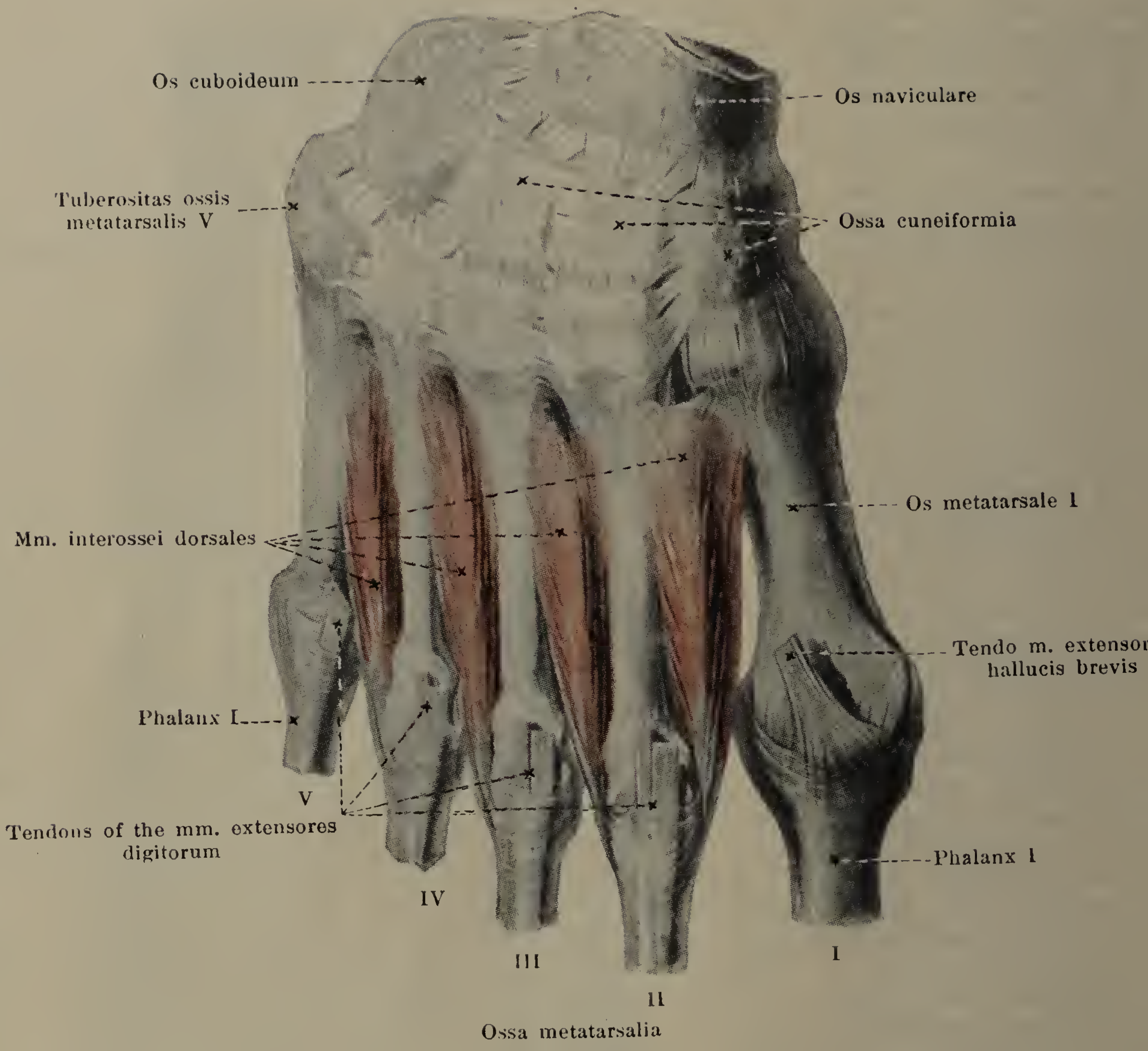
(The mm. tibialis anterior and extensores longi as well as the inferior limb of the lig. cruciatum cruris have been removed.)


M. extensor hallucis longus
M. extensor digitorum longus
M. peronaeus longus
Malleolus lateralis
Ligamentum cruciatum cruris
Retinaculum mm. peronaeorum inferius
M. peronaeus brevis
M. extensor digitorum brevis
M. peronaeus tertius (cut off)
M. abductor digiti V
Mm. interossei dorsales
Tendines m. extensoris digitorum longi
Tibia
Ligamentum transversum cruris
Compartment for the m. tibialis anterior
Malleolus medialis
Compartment for the m. tibialis anterior
Compartment for the m. extensor hallucis longus
Compartment for the m. extensor digitorum longus
Tendo m. tibialis anterioris
M. extensor hallucis brevis
B. subtendinea m. tibialis anterioris
Tendo m. extensoris hallucis longi
M. abductor hallucis
Bursae intermetatarsophalangeae

M. extensor digitorum brevis (see also Figs. 441, 452 and 460). Form: flat, triangular. Position: upon the back of the foot, directly upon the bones, partly covered by the tendons of the mm. extensor digitorum longus and peronaeus III. Origin: lateral and superior surface of the corpus calcanei, in front of the entrance into the sinus tarsi, covered by the lateral limb of the lig. cruciatum cruris. Insertion: the fibres diverge forward and form four small muscular bellies, which, upon the ossa metatarsalia, go over into four flat, delicate tendons. Of these, the three lateral run to the first phalanx of the 2nd—4th toe, fuse with the corresponding tendons of the m. extensor digitorum longus and go with the latter to the second and third phalanx. The medial, strongest tendon, along with the muscle belonging to it, which is mostly distinctly separated is given a special name, being called the **m. extensor hallucis brevis;** it extends obliquely medianward and becomes attached to the base of the first phalanx of the great toe (see also Fig. 454). Action: it draws the 1st—4th toe dorsalward and lateralward. Innervation: n. peronaeus profundus (L_4, L_5, S_1).

Bursa subtendinea m. tibialis anterioris (see also Fig. 457), very frequently present, between the medial surface of the os cuneiforme I and the tendon of the m. tibialis anterior.

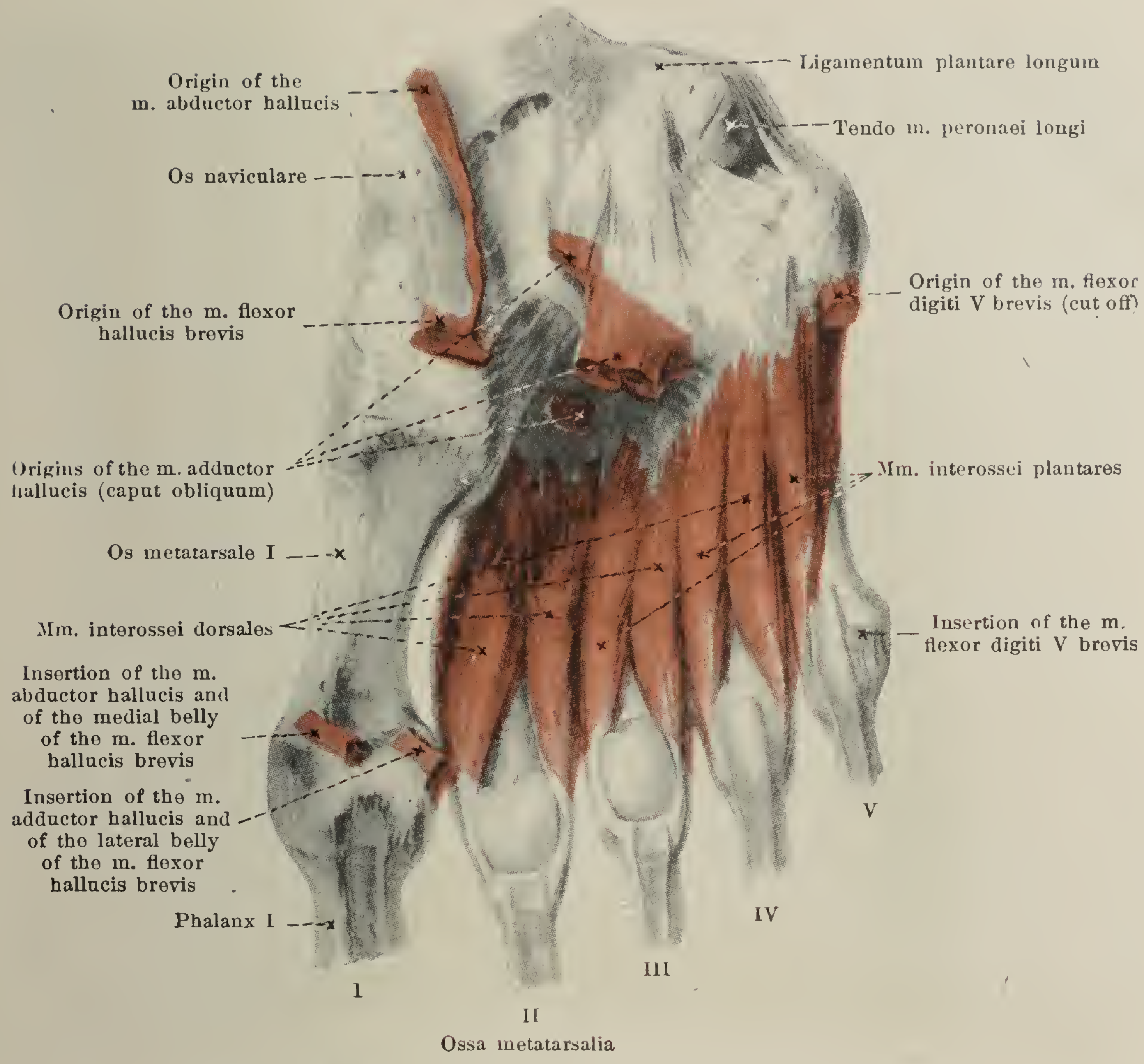
Bursae intermetatarsophalangeae (see also Figs. 458 and 459), four, between the heads of the ossa metatarsalia; the three medial almost constant, the fourth only occasionally present.



454. Mm. interossei dorsales pedis dextri,

viewed from the dorsal surface of the foot.

Mm. interossei dorsales (see also Fig. 455), four. Form: oblong-triangular, bipinnate, small. Position: in the interspaces between the ossa metatarsalia, projecting somewhat plantarward; covered dorsalward by all the muscles of the back of the foot, plantarward by all the muscles of the sole of the foot. Origin: from the adjacent sides of each pair of ossa metatarsalia. Insertion: the fibres of each muscle run converging forward to a small tendon; this extends dorsalward from the lig. capitulorum [oss. metatars.] transversum to the lateral surface of the base of the first phalanx and also may go to the triangular expansions of the tendons of the mm. extensores digitorum. The tendon of the first (most medially situated) muscle runs on the medial side of the 2nd toe, while the tendons of the second to the fourth muscle lie on the lateral surface of the 2nd—4th toe. Action: the first draws the first os metatarsale toward the second; the first draws the first phalanx of the 2nd toe medianward, the others draw the first phalanx of the 2nd—4th toe lateralward; all usually only flex the first phalanx of these toes, without extending the 2nd and 3rd phalanx as in the hand. Innervation: n. plantaris lateralis (S_1, S_2).


Origin of the m. abductor hallucis
Os naviculare
Origin of the m. flexor hallucis brevis
Origins of the m. adductor hallucis (caput obliquum)
Os metatarsale I
Mm. interossei dorsales
Insertion of the m. abductor hallucis and of the medial belly of the m. flexor hallucis brevis
Insertion of the m. adductor hallucis and of the lateral belly of the m. flexor hallucis brevis
Phalanx I
Ligamentum plantare longum
Tendo m. peronaei longi
Origin of the m. flexor digiti V brevis (cut off)
Mm. interossei plantares
Insertion of the m. flexor digiti V brevis
V
IV
III
I
II
Ossa metatarsalia

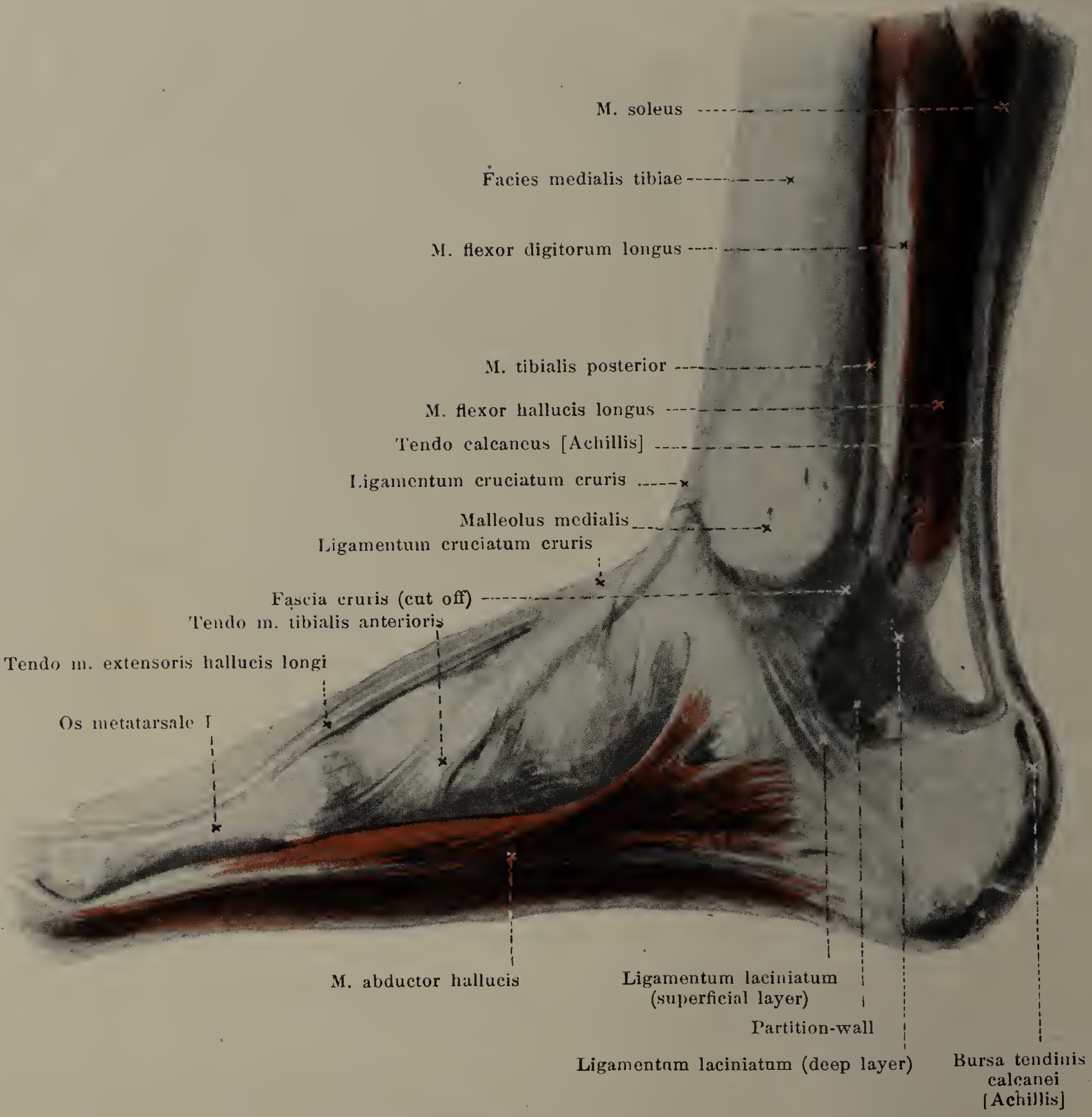
455. Mm. interossei pedis dextri,

viewed from the plantar surface.

M. flexor digiti quinti brevis (O. T. flexor brevis minimi digiti pedis) (see also Figs. 449—451). Form: rounded, narrow, small. Position: in the sole of the foot, on the plantar surface of the os metatarsale V, partly covered plantarward by the m. abductor digiti V, otherwise only by the aponeurosis plantaris. Origin: basis oss. metatarsalis V and lig. plantare longum. Insertion: the fibres run converging forward and, becoming tendinous, go to the base of the first phalanx of the little toe. Action: it draws the 1st phalanx of the little toe plantarward and lateralward. Innervation: n. plantaris lateralis (S_1, S_2).

M. opponens digiti quinti (see Figs. 451 and 458), often absent. Form: flat, triangular, small. Position: directly upon the plantar surface of the os metatarsale V, covered plantarward by the m. abductor digiti V, bounded medianward by the m. flexor digiti V. Origin: lig. plantare longum, fused with the m. flexor digiti V brevis. Insertion: the fibres run forward and somewhat lateralward to the os metatarsale V. Action: it draws the little toe plantarward and medianward. Innervation: n. plantaris lateralis (S_1, S_2).

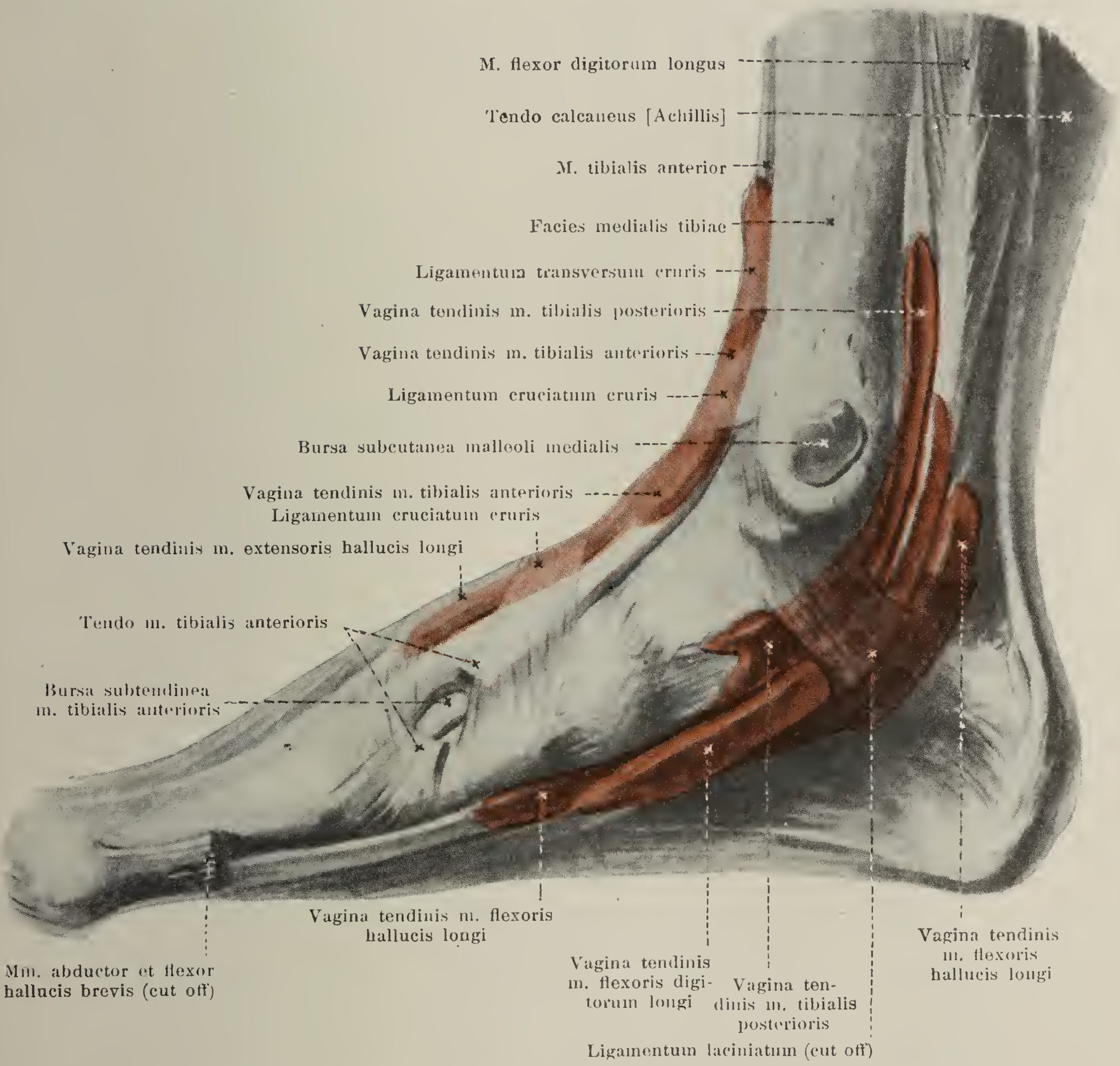
Mm. interossei plantares, three. Form: oblong-spindle-shaped, small. Position: in the interspaces between the ossa metatarsalia II—V, plantarward from the mm. interossei dorsales; projecting somewhat toward the sole of the foot and covered there by all the muscles of the sole of the foot. Origin: from the medial surface of the ossa metatarsalia III—V. Insertion: the fibres of each muscle go, converging, forward to a narrow tendon, which extends dorsally from the lig. capitulorum [oss. metatarsalium] transversum to the medial surface of the basis of the first phalanx and also may go to the triangular expansions of the tendons of the mm. extensores digitorum. The three mucles run on the medial side of the 3rd—5th toe. Action: they draw the first phalanx of the 3rd—5th toe medianward and generally only flex their first phalanx, without extending the 2nd and 3rd phalanx as in the hand. Innervation: n. plantaris lateralis (S_1, S_2).


M. soleus
Facies medialis tibiae
M. flexor digitorum longus
M. tibialis posterior
M. flexor hallucis longus
Tendo calcaneus [Achillis]
Ligamentum cruciatum cruris
Malleolus medialis
Ligamentum cruciatum cruris
Fascia cruris (cut off)
Tendo m. tibialis anterioris
Tendo m. extensoris hallucis longi
Os metatarsale I
M. abductor hallucis
Ligamentum laciniatum (superficial layer)
Partition-wall
Ligamentum laciniatum (deep layer)
Bursa tendinis calcanei [Achillis]

456. Muscles of the right foot, viewed from the medial surface.

M. abductor hallucis (see also Figs. 449—452 and 455). Form: flat, oblong-triangular, bipinnate. Position: superficial on the medial margin of the sole of the foot; bounded lateralward by the mm. flexor digitorum brevis and flexor hallucis brevis. Origin: medial surface of the tuber calcanei, superficial layer of the lig. laciniatum and malleolus medialis; also from the tuberositas oss. navicularis and the plantar surface of the os cuneiforme I. Insertion: the fibres converge to a tendinous strip, lying in the muscle, which goes over into a flat, strong tendon; this is fused in front with the medial belly of the m. flexor hallucis brevis and goes to the medial sesamoid bone and to the base of the first phalanx of the great toe. Action: it draws the first phalanx of the great toe medianward and plantarward. Innervation: n. plantaris medialis (L_5, S_1).

Ligamentum laciniatum (O. T. internal annular ligament) (see also Figs. 319, 445, 446, 451, 457 and 458) is a strengthening band in the lower part of the fascia cruris, below and behind the malleolus medialis. It goes off from the posterior and inferior margins of the malleolus medialis, covers the tendon of the m. tibialis posterior and holds it fast on the subjacent bone; it then divides into two layers. The superficial layer is stretched out from there to the medial surface of the tuber calcanei and goes over above into the two united layers of the fascia cruris (see p. 365); proximally it frequently has a sharp concave margin, sometimes without sharp limit; distally it serves as an origin to the fibres of the m. abductor hallucis. (Continued on p. 379.)


M. flexor digitorum longus
Tendo calcaneus [Achillis]
M. tibialis anterior
Facies medialis tibiae
Ligamentum transversum cruris
Vagina tendinis m. tibialis posterioris
Vagina tendinis m. tibialis anterioris
Ligamentum cruciatum cruris
Bursa subcutanea malleoli medialis
Vagina tendinis m. tibialis anterioris
Ligamentum cruciatum cruris
Vagina tendinis m. extensoris hallucis longi
Tendo m. tibialis anterioris
Bursa subtendinea m. tibialis anterioris
Mm. abductor et flexor hallucis brevis (cut off)
Vagina tendinis m. flexoris hallucis longi
Vagina tendinis m. flexoris digitorum longi
Vagina tendinis m. tibialis posterioris
Ligamentum laciniatum (cut off)
Vagina tendinis m. flexoris hallucis longi

457. Bursae and sheaths of tendons of the right foot, injected (sheaths of tendons stained red), viewed from the medial surface.

(The mm. abductor hallucis and flexor hallucis brevis have been removed.)

Ligamentum laciniatum (continued). The deep layer passes just behind the tendons of the mm. flexor digitorum longus and flexor hallucis longus to the medial surface of the calcaneus, is firmly attached to the margins of the corresponding bony grooves and holds the tendons firmly upon the bones; it reaches above as far as the malleolus and is continous with the vascular sheath. Between the two layers is a canal for the aa.; vv. and nn. plantares; a septum, rarely absent, separates the medial branches from the lateral.

Bursa subcutanea malleoli medialis (see also Fig. 459), frequently present, upon the malleolus medialis.

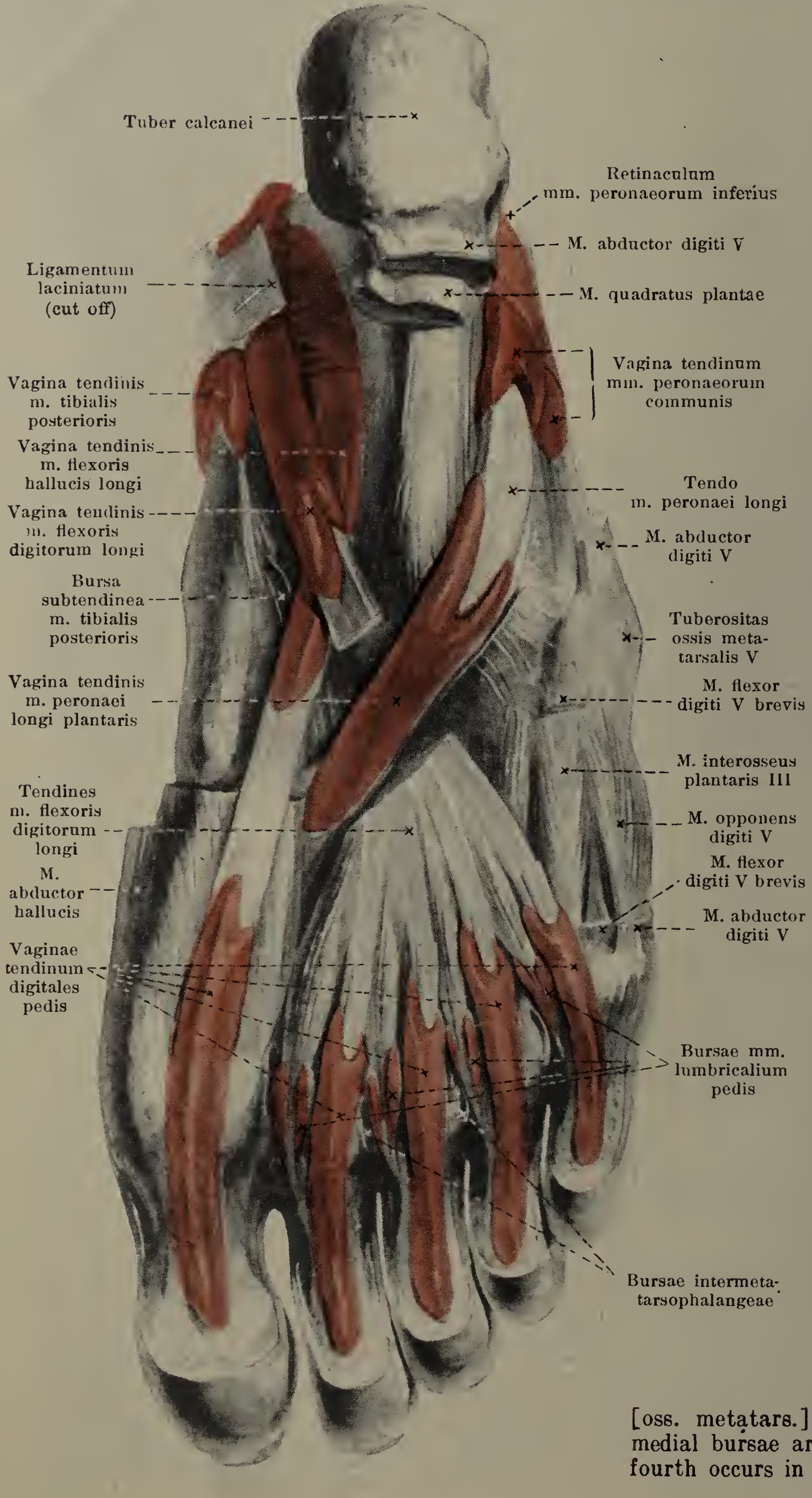
Vagina tendinis m. tibialis posterioris (see also Fig. 458) begins over the medial malleolus and ends at the os naviculare; it frequently communicates above with the following.

Vagina tendinis m. flexoris digitorum pedis longi (see also Fig. 458) begins below the preceding and ends in the sole of the foot at the point where its tendon crosses that of the m. flexor hallucis longus, below the os naviculare; above it communicates sometimes with the preceding sheath, below sometimes with the following.

Vagina tendinis m. flexoris hallucis longi (see also Fig. 458) begins below the preceding and ends at or in front of the point where the tendon of the m. flexor digitorum longus is crossed, below the os naviculare; there it sometimes communicates with the preceding.

458. Bursae and sheaths of tendons of the sole of the right foot, injected; sheaths of tendons stained red.

(The short muscles of the 1st and 2nd layer have been for the most part removed.)


Tuber calcanei
Retinaculum mm. peronaeorum inferius
M. abductor digiti V
Ligamentum laciniatum (cut off)
M. quadratus plantae
Vagina tendinum mm. peronaeorum communis
Vagina tendinis m. tibialis posterioris
Vagina tendinis m. flexoris hallucis longi
Tendo m. peronaei longi
Vagina tendinis m. flexoris digitorum longi
M. abductor digiti V
Bursa subtendinea m. tibialis posterioris
Tuberositas ossis metatarsalis V
Vagina tendinis m. peronaei longi plantaris
M. flexor digiti V brevis
M. interosseus plantaris III
Tendines m. flexoris digitorum longi
M. opponens digiti V
M. abductor hallucis
M. flexor digiti V brevis
M. abductor digiti V
Vaginae tendinum digitales pedis
Bursae mm. lumbricalium pedis
Bursae intermetatarsophalangeae

Bursa subtendinea m. tibialis posterioris, frequently present, oblong-trough-shaped, between the lateral tendinous process of the m. tibialis posterior (see Fig. 319) on one side, the ossa naviculare and cuneiforme II on the other side.

Vagina tendinis m. peronaei longi plantaris begins at the sulcus m. peronaei [longi] of the os cuboideum and ends at about the medial margin of the lig. plantare longum; it communicates only rarely with the vagina tendinum mm. peronaeorum communis.

Vaginae tendinum digitales pedis, five, one on the volar surface of each toe; they begin behind, at the great toe in the neighborhood of the base, on the other toes in the neighborhood of the heads of the ossa metatarsalia, and terminate near the terminal phalanx; they are surrounded like those in the fingers (see p. 340) by the ligg. vaginalia with the ligg. cruciata and annularia; they never communicate with the sheaths which lie more proximalward.

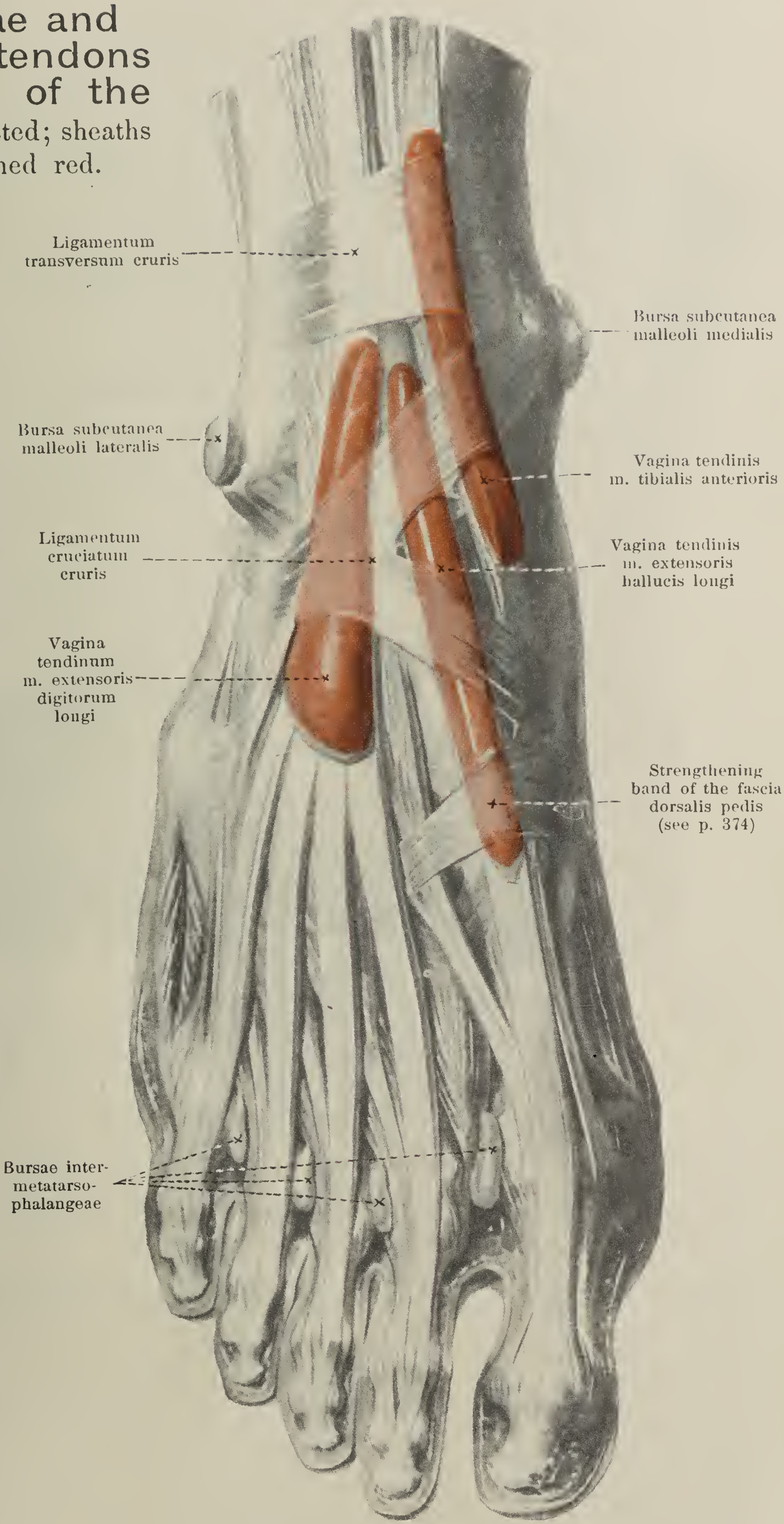
Bursae mm. lumbricalium pedis, four, lying on the anterior extremities of the mm. lumbricales, between them and the ligg. capitulorum [oss. metatars.] transversa; the three medial bursae are almost constant, the fourth occurs in half the cases.

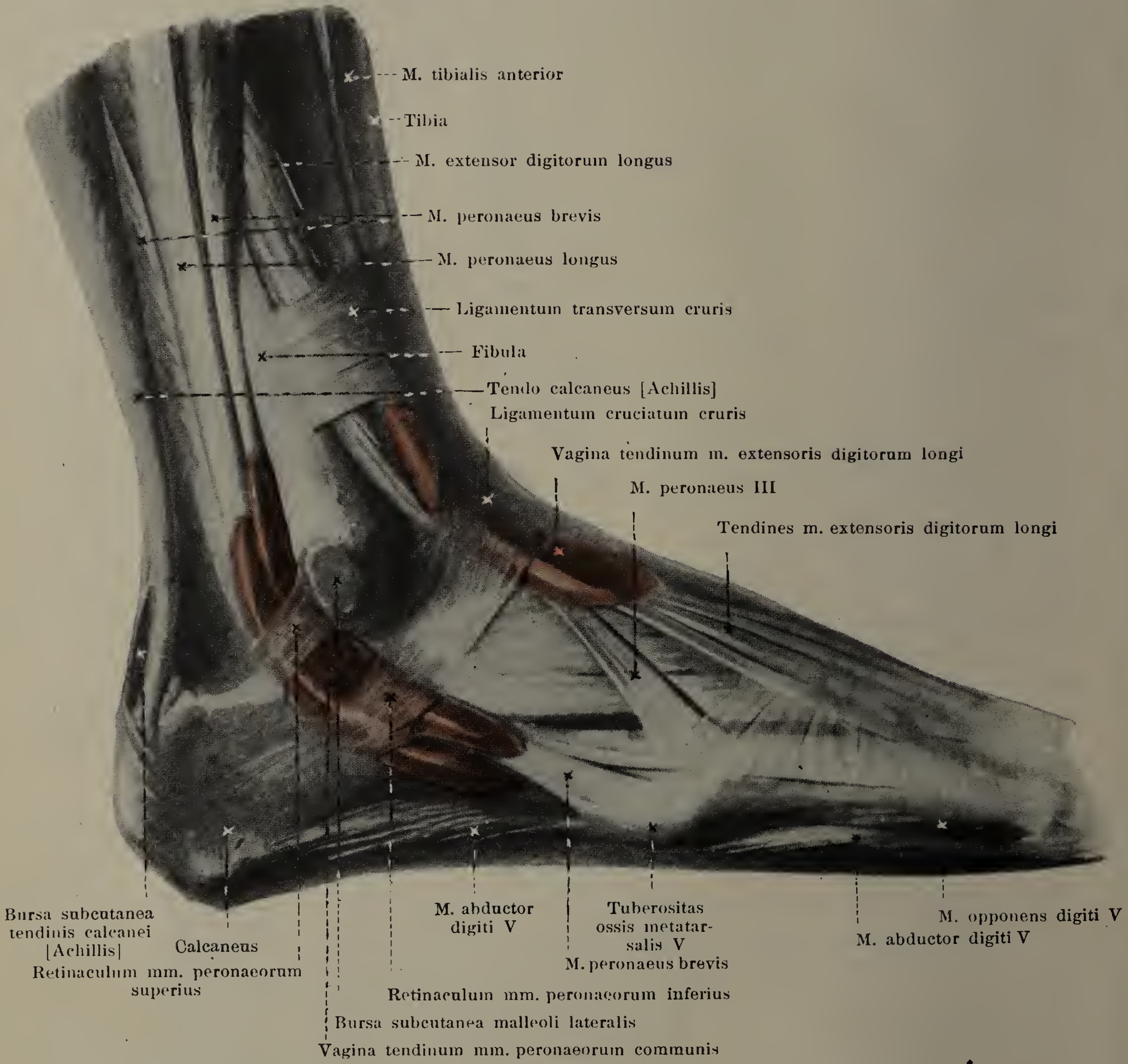
459. Bursae and sheaths of tendons of the back of the right foot, injected; sheaths of tendons stained red.

Vagina tendinis m. tibialis anterioris (see also Fig. 457) begins somewhat above the lig. transversum cruris and ends usually somewhat above the articulatio talonavicularis.

Vagina tendinis m. extensoris hallucis longi (see also Fig. 457) begins as the most deeply situated of the anterior tendon sheaths, below the lig. transversum cruris and ends farthest forward in the region of the articulatio tarsometatarsea of the great toe, distalward from the strengthening band situated there (see p. 374); the distal end sometimes has the appearance of being pinched off.

Vagina tendinum m. extensoris digitorum pedis longi (see also Fig. 460) forms a sheath for the tendons of the m. extensor digitorum longus and of the m. peronaeus III; it begins somewhat above the preceding below the lig. transversum cruris and ends over the middle of the os cuneiforme III.


Ligamentum transversum cruris
Bursa subcutanea malleoli medialis
Bursa subcutanea malleoli lateralis
Vagina tendinis m. tibialis anterioris
Ligamentum cruciatum cruris
Vagina tendinis m. extensoris hallucis longi
Vagina tendinum m. extensoris digitorum longi
Strengthening band of the fascia dorsalis pedis (see p. 374)
Bursae intermetatarsophalangeae

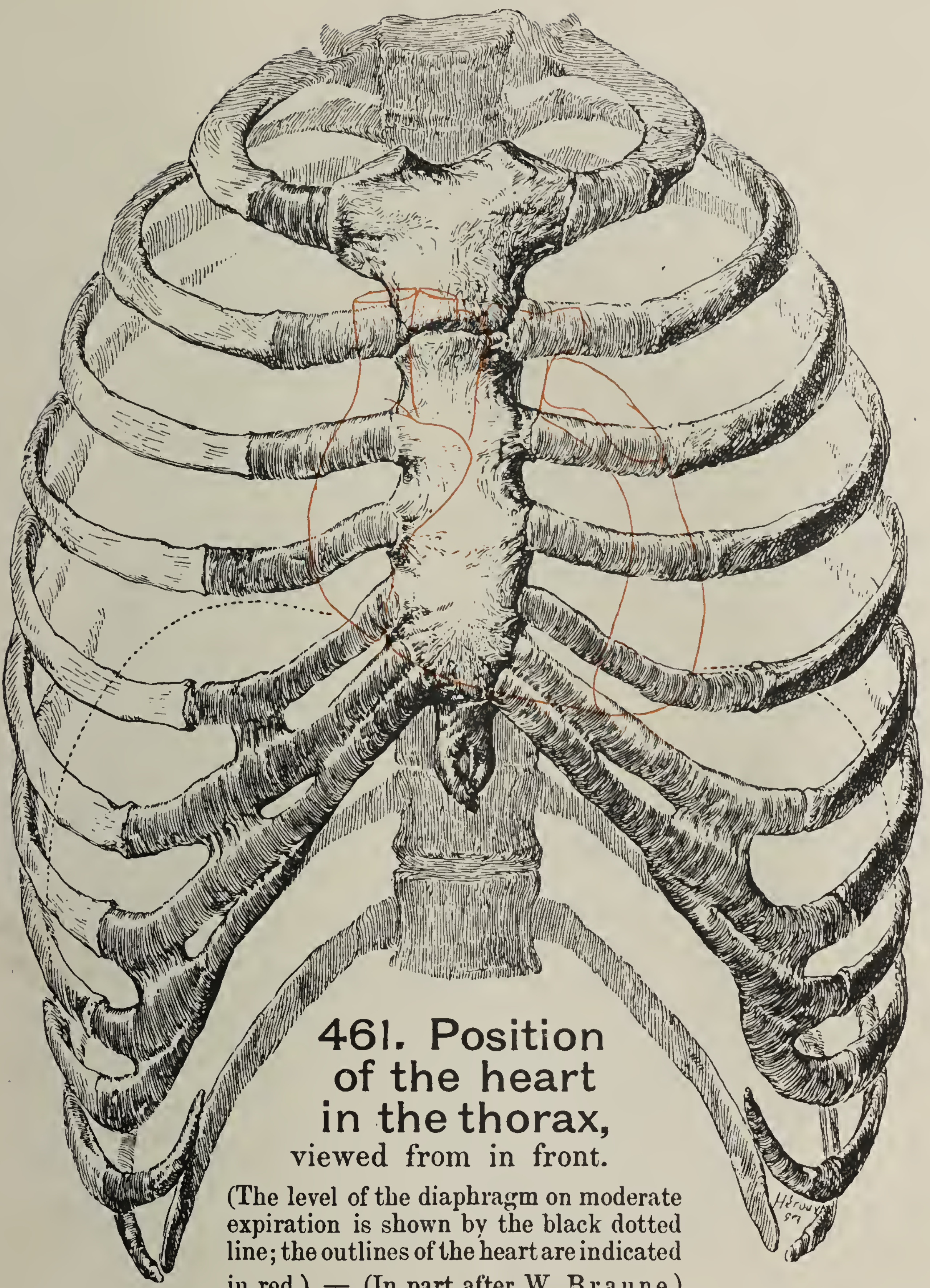

M. tibialis anterior
Tibia
M. extensor digitorum longus
M. peronaeus brevis
M. peronaeus longus
Ligamentum transversum cruris
Fibula
Tendo calcaneus [Achillis]
Ligamentum cruciatum cruris
Vagina tendinum m. extensoris digitorum longi
M. peronaeus III
Tendines m. extensoris digitorum longi
Bursa subcutanea tendinis calcanei [Achillis]
Calcaneus
Retinaculum mm. peronaeorum superius
M. abductor digiti V
Tuberositas ossis metatarsalis V
M. peronaeus brevis
M. opponens digiti V
M. abductor digiti V
Retinaculum mm. peronaeorum inferius
Bursa subcutanea malleoli lateralis
Vagina tendinum mm. peronaeorum communis

460. Bursae and sheaths of tendons of the right foot,

injected (sheaths of tendons stained red), viewed from the lateral surface.

Bursa subcutanea malleoli lateralis (see also Figs. 441 and 459), very frequently present, upon the malleolus lateralis.

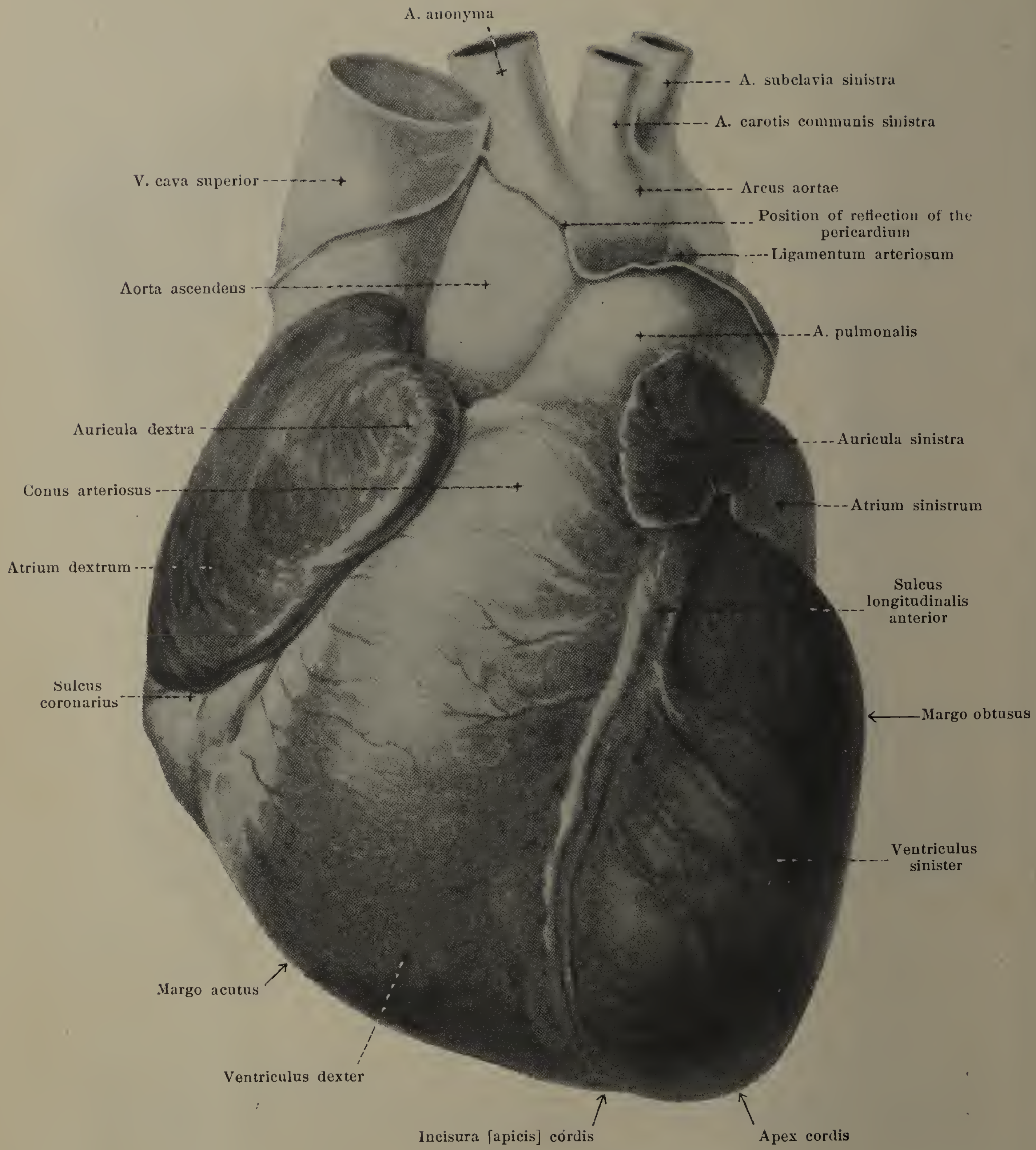
Vagina tendinum mm. peronaeorum communis (see also Fig. 458) surrounds the tendons of the mm. peronaei and bifurcates, at its proximal end for a shorter, at its distal end for a longer, distance into two parts, one for each tendon. It begins above the malleolus lateralis and ends at the beginning of the tuberositas oss. cuboidei; it communicates there only rarely with the vagina tendinis m. peronaei longi plantaris. Behind and below the malleolus it may communicate with the joint cavity of the articulatio talocruralis.



461. Position of the heart in the thorax, viewed from in front.

(The level of the diaphragm on moderate expiration is shown by the black dotted line; the outlines of the heart are indicated in red.) — (In part after W. Braune.)

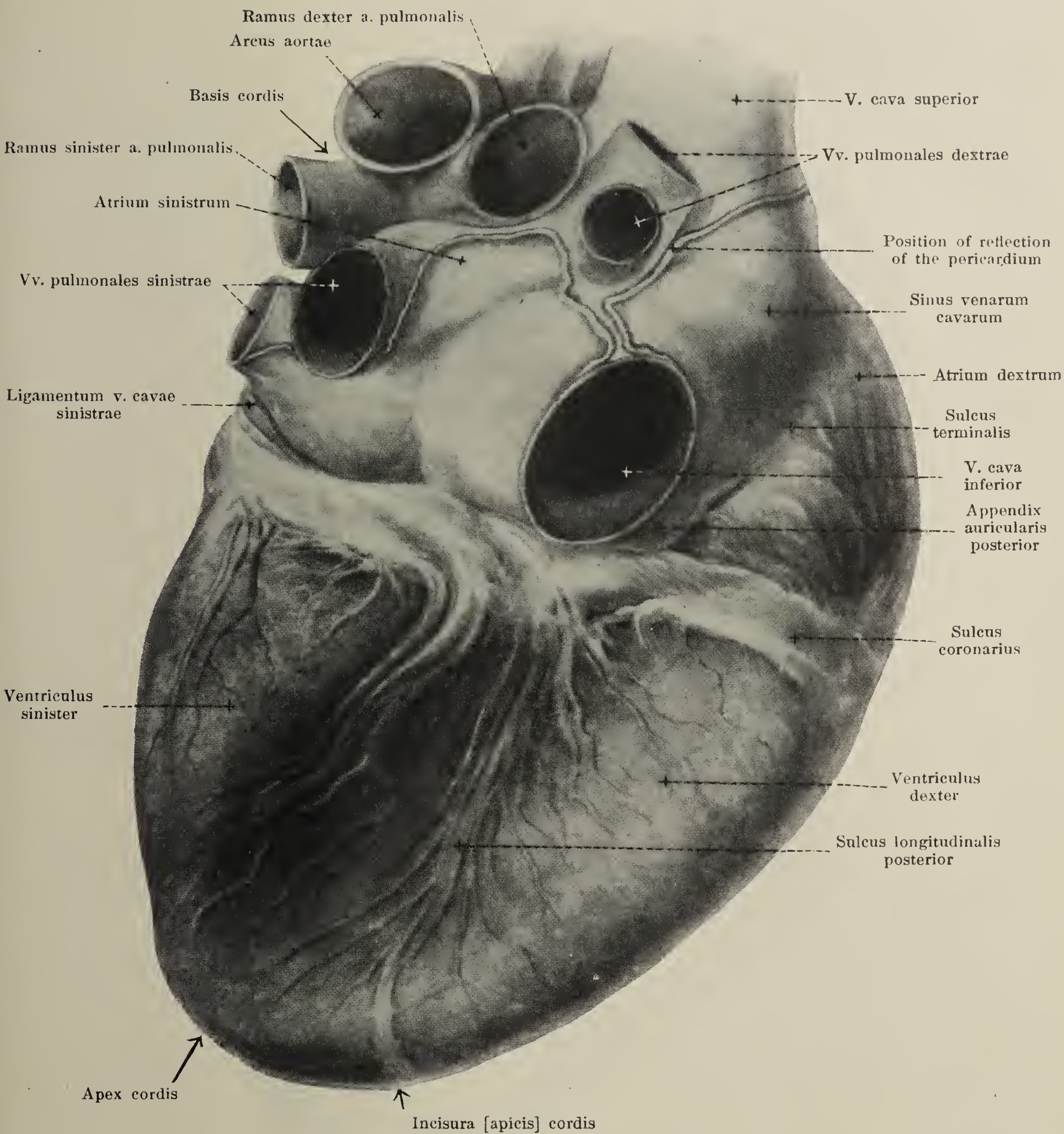
The **heart (cor)** is an almost wedge-shaped, hollow, muscular body, intercalated as a pressure-pump in the circulatory system. It consists of two *fore-chambers* (O. T. auricles), the *atrium dextrum* and *atrium sinistrum*, and of two ventricles, the *ventriculus dexter* and *ventriculus sinister*, of which, after birth, the right auricle communicates only with the right ventricle, and the left auricle only with the left ventricle. The blood flows from the auricle into the ventricle through its *ostium venosum* and leaves the ventricle through its *ostium arteriosum*. The heart is situated asymmetrically in the middle of the thorax, so that the smaller part is on the right, the greater part on the left side (see also Fig. 683). The base of the heart *(basis cordis)* formed by the auricles is directed somewhat backwards and to the right, the apex of the heart, *apex cordis* (formed by the left ventricle alone), looks forward and to the left and comes into direct contact with the chest-wall in the 5th intercostal space, somewhat medial from the costocartilaginous junction. The *ostium arteriosum dextrum* (O. T. pulmonary orifice) lies usually at the sternal end of the left 3rd intercostal space, or behind the left 3rd costal cartilage; the *ostium arteriosum sinistrum* (O. T. aortic orifice) lies somewhat more medianward and downward, close below the middle of the left half of the sternum at the level of the 3rd intercostal space. The middle point of the *ostium venosum dextrum* (O. T. right auriculoventricular opening) lies behind the right half of the sternum at the level of the sternal end of the right 4th intercostal space; the *ostium venosum sinistrum* (O. T. left auriculoventricular opening) lies behind the sternal end of the 3rd left intercostal space.



462. The heart, moderately distended, viewed from above and in front.

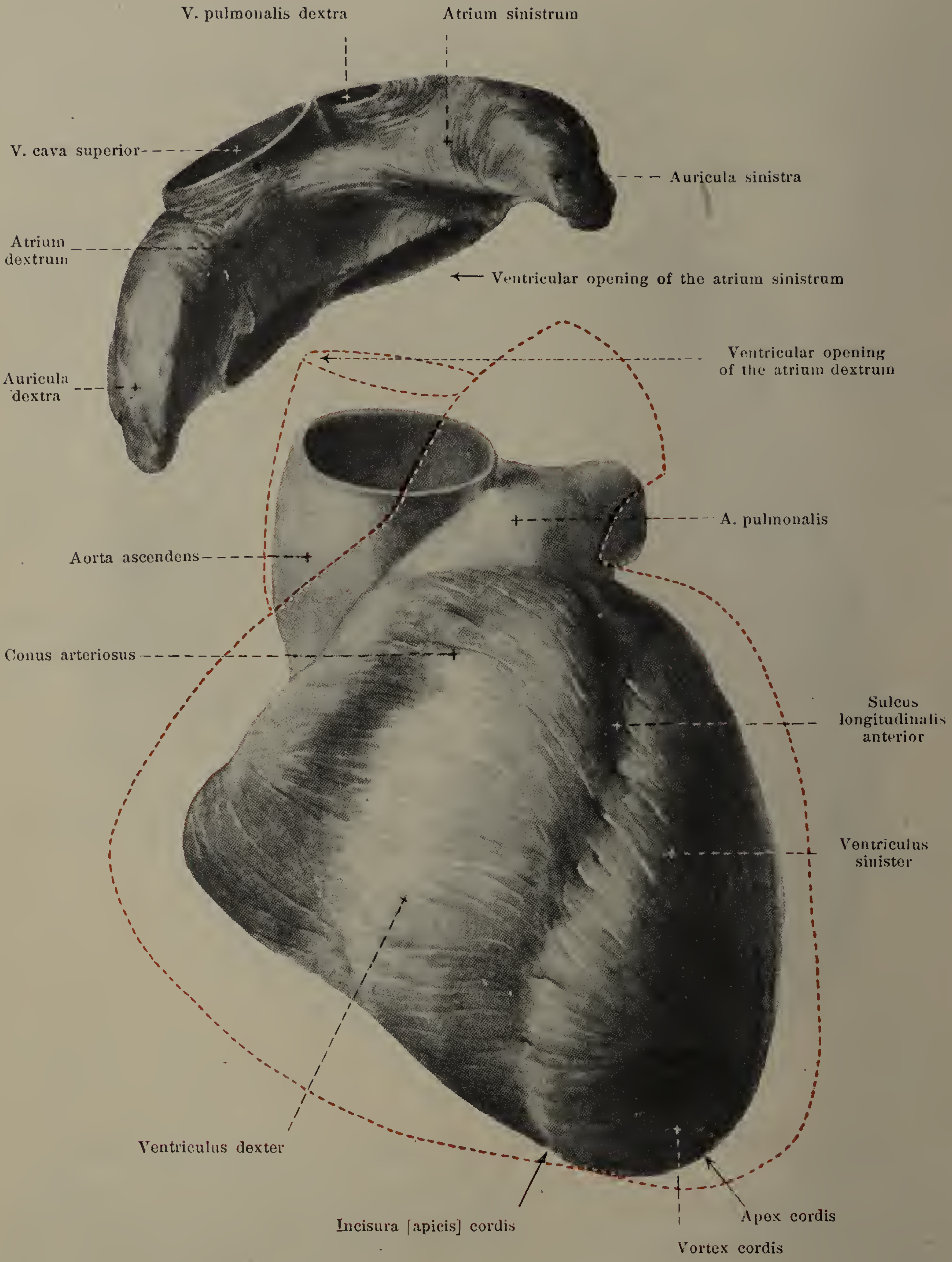
(Facies sternocostalis.)

The **heart** presents for examination an inferior, almost plane surface, lying upon the diaphragm, the *facies diaphragmatica* (O. T. posterior surface), and a markedly curved surface looking upward and forward, the *facies sternocostalis* (O. T. anterior surface); the latter lies partly just behind the sternum and behind the anterior ends of the 3rd to the 6th pair of ribs, in part it is overlapped by the margins of the lungs. The two corresponding chamber-surfaces pass on the right rather suddenly into one another, thus forming a sort of margin, *margo acutus,* whilst on the left the transition takes place gradually, and is termed *margo obtusus;* these two „margins“ converge at the apex of the heart.



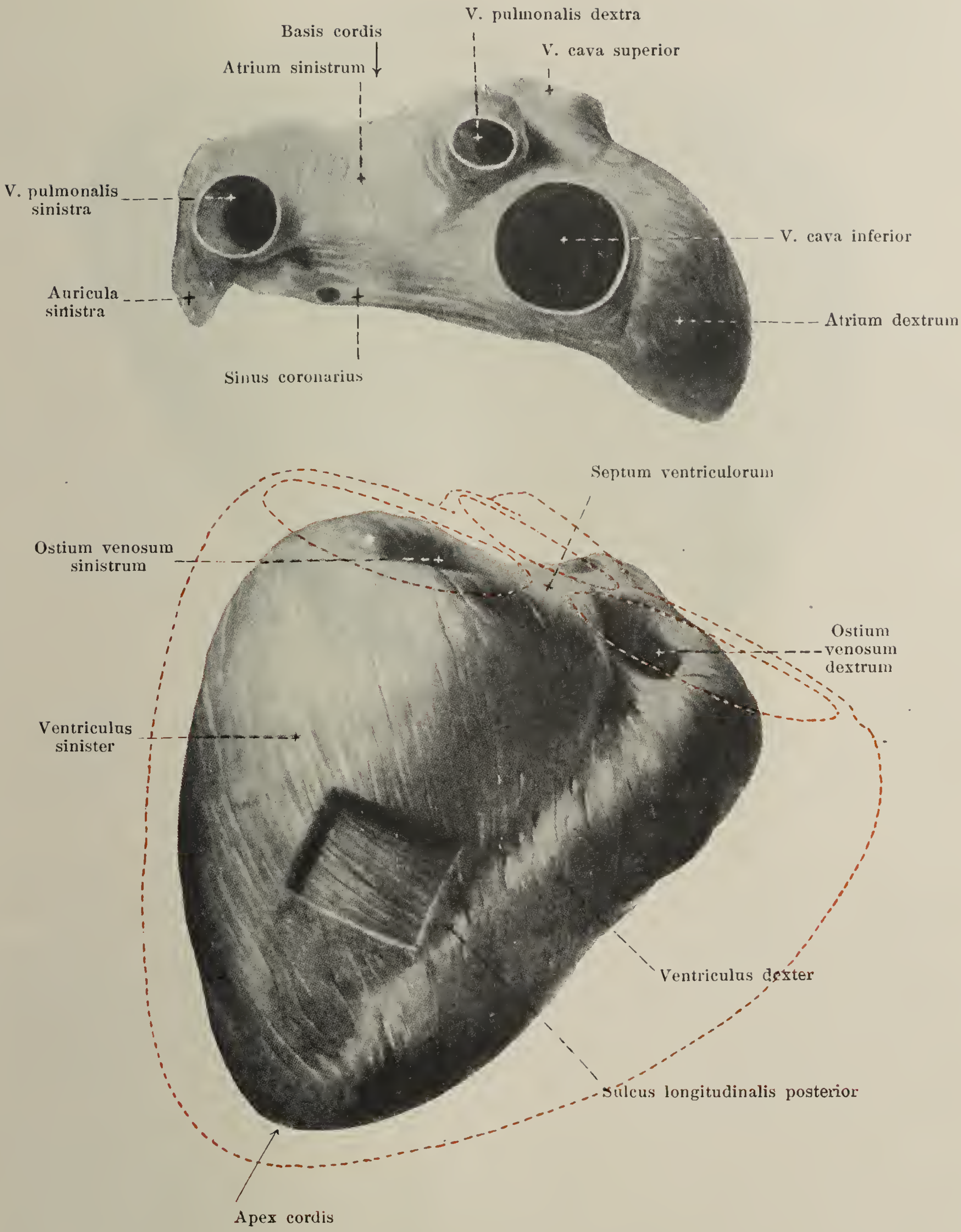
463. The heart, moderately distended, viewed from below.
(Facies diaphragmatica.)

The **heart:** the fore-chambers are separated from the ventricles by a groove, the *sulcus coronarius* (O. T. auriculoventricular groove), which is usually filled up with bloodvessels and fat; it runs nearly perpendicular to the long axis drawn from the apex to the middle of the base and is on the sternocostal surface in part hidden by the beginning of the a. pulmonalis and aorta. Corresponding to the septum between the two ventricles, on the inferior surface runs fairly straight the ***sulcus longitudinalis posterior*** (O. T. posterior interventricular groove); on the upper surface runs twisted so as to be somewhat S shaped from the base toward the apex the ***sulcus longitudinalis anterior*** (O. T. anterior interventricular groove). The latter sulcus begins, covered by the left auricular appendix, on the left side of the a. pulmonalis and meets the sulcus longitudinalis posterior at the right of the apex of the heart in a shallow groove, the ***incisura [apicis] cordis.***



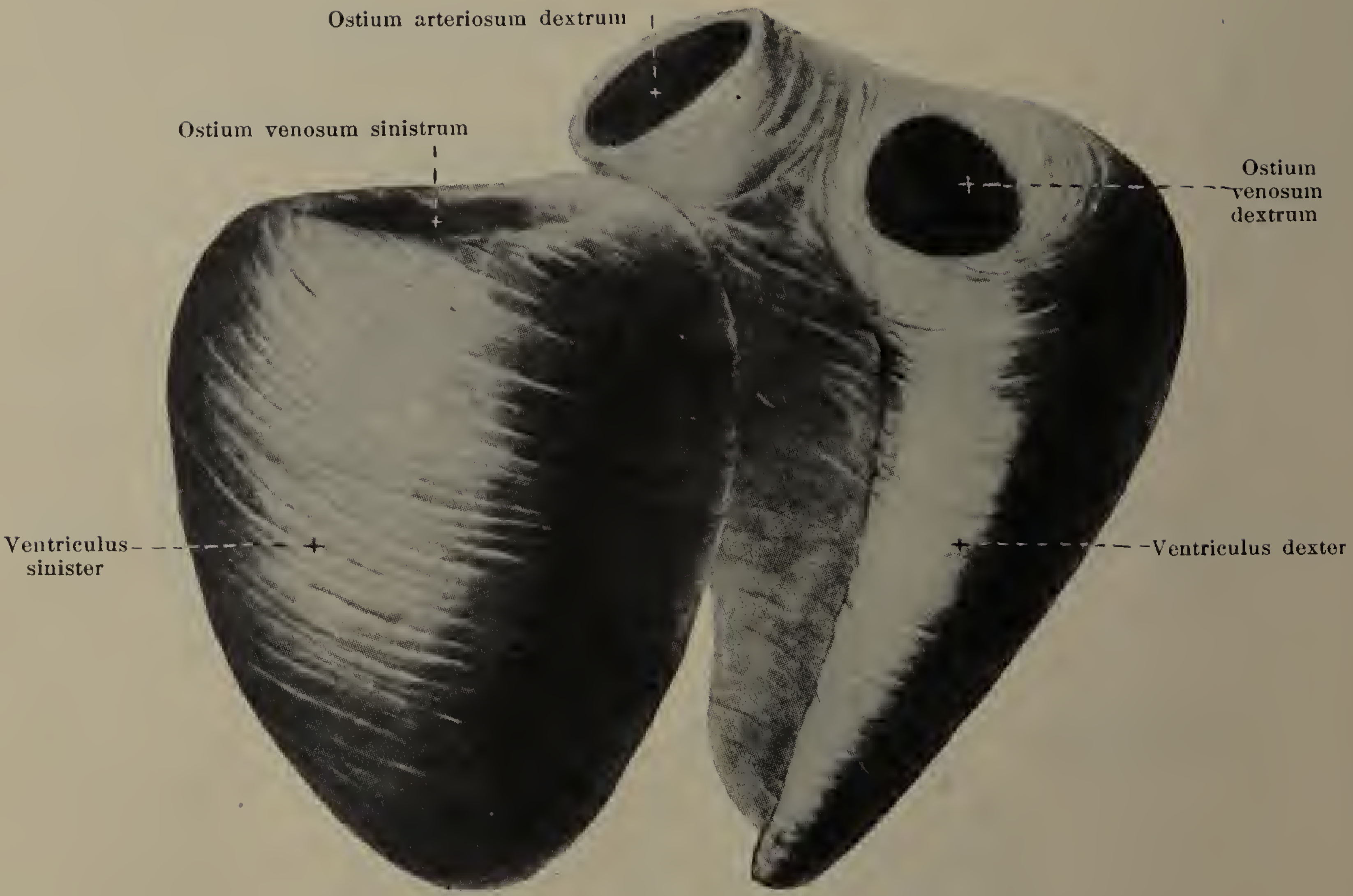
464. Superficial muscle layer of a maximally contracted heart, viewed from above and in front.

(The fore-chambers have been dissected off. The outlines of the dilated ventricles of the heart are indicated in red, the position of the ostium arteriosum sinistrum being assumed to be fixed.)



465. Superficial muscle layer of a maximally contracted heart, viewed from below.

(The fore-chambers have been dissected off. Two windows have been cut into the superficial muscle layer in order to show the deeper bands of fibres. The outlines of the dilated ventricles of the heart are indicated in red, the position of the ostium arteriosum sinistrum being assumed to be fixed.)



466. The musculature of the ventricles of the heart, dissected free from one another; drawn apart; viewed from below. Somewhat schematically represented.

(On the right and left the superficial muscle is shown.)

The **heart** is covered on its outer surface by the visceral layer of the pericardium, the *epicardium*, on its inner surface by the *endocardium;* the main mass of the wall is formed of muscle, the *myocardium* (see Fig. 472).

***Musculature** of the heart.* Owing to the network-like arrangement, the elements of the heart muscle bundles cannot be as sharply delimited as in the skeletal musculature. Besides, the bundles undergo manifold anastomosis with one another. The anastomoses appear as flat layers in the superficial portions so that there one can recognize a distinct lamellation, while in the depth, where the anastomoses are more evenly developed in all directions, the layers are far less marked. In spite of this there is a dominant direction of the course of the fibres; it is this only that will be described in what follows. The reader should notice that the direction of the fibres in the directly successive layers changes only gradually.

The *musculature *) of the fore-chambers* (see Figs. 464 and 465) is very thin and partly little regular. On the posterior and especially on the anterior surface fibres go transversely from the wall of one atrium to that of the other; otherwise the fibres run arch-like around the mouths of the veins and continue as rings on the termination of the vv. pulmonales as far as to the reflection of the pericardium; the point of origin of the left auricular appendix is also surrounded by nearly ring-like fibres. On the inner surface of the right fore-chamber strong muscle fibres form the substratum of the crista terminalis and of the limbus fossae ovalis; those of the latter also send a strong bundle into the tuberculum intervenosum; the muscle bands arise in the region of the trigonum fibrosum dextrum. From the muscle band of the crista terminalis the mm. pectinati take their origin (see p. 394). In addition, some fibres go over directly into the radial fibre-layer of the valvulae tricuspidalis and bicuspidalis (see page 393). The lumen of the auricular appendices is traversed by numerous irregularly arranged muscular columns *(trabeculae carneae).*

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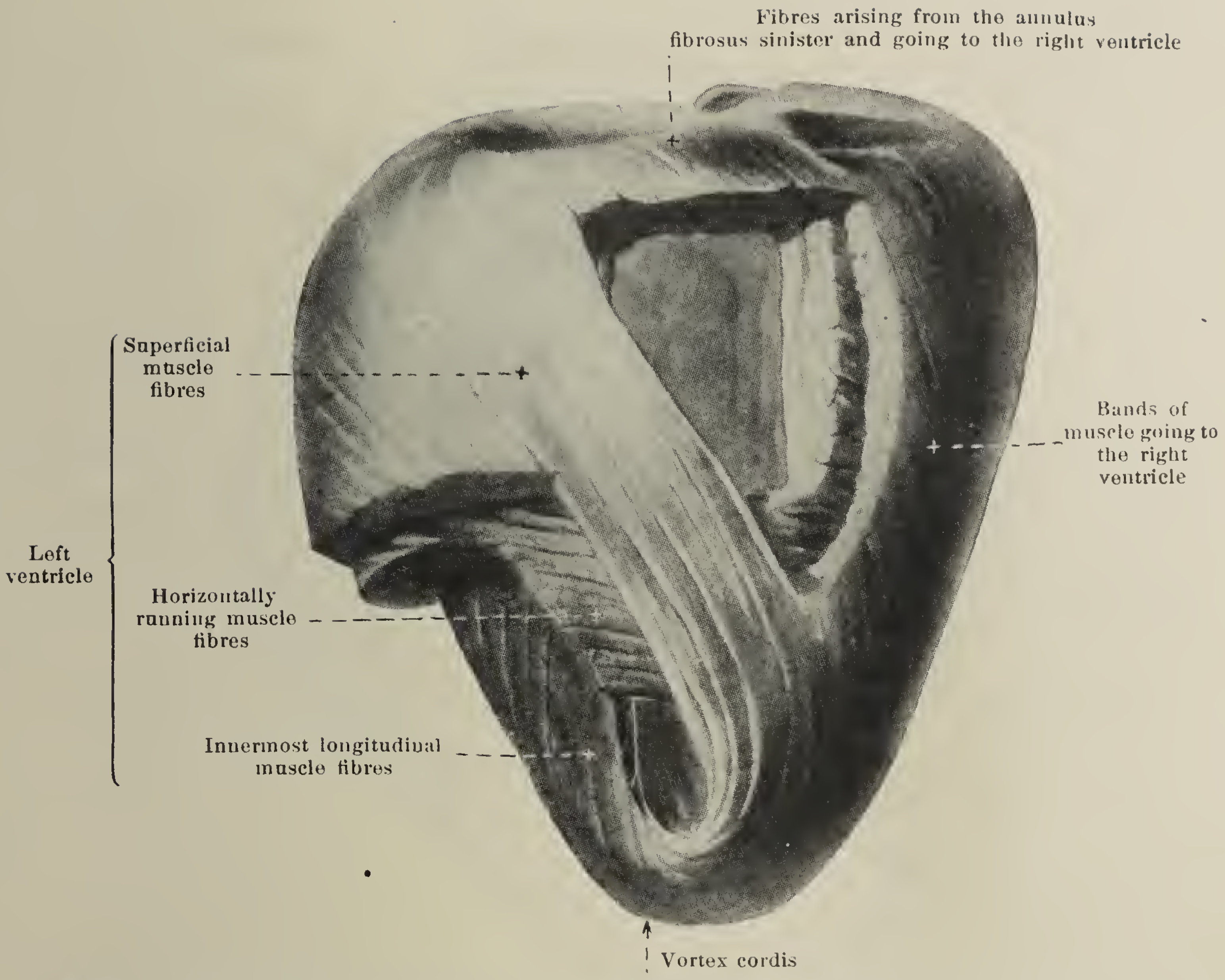
*) In the description of the musculature (pp. 388—389^{b}) the heart is thought as being placed with the base upward, the facies diaphragmatica backward and the apex downward.


Fibres arising from the annulus fibrosus sinister and going to the right ventricle
Superficial muscle fibres
Bands of muscle going to the right ventricle
Left ventricle
Horizontally running muscle fibres
Innermost longitudinal muscle fibres
Vortex cordis

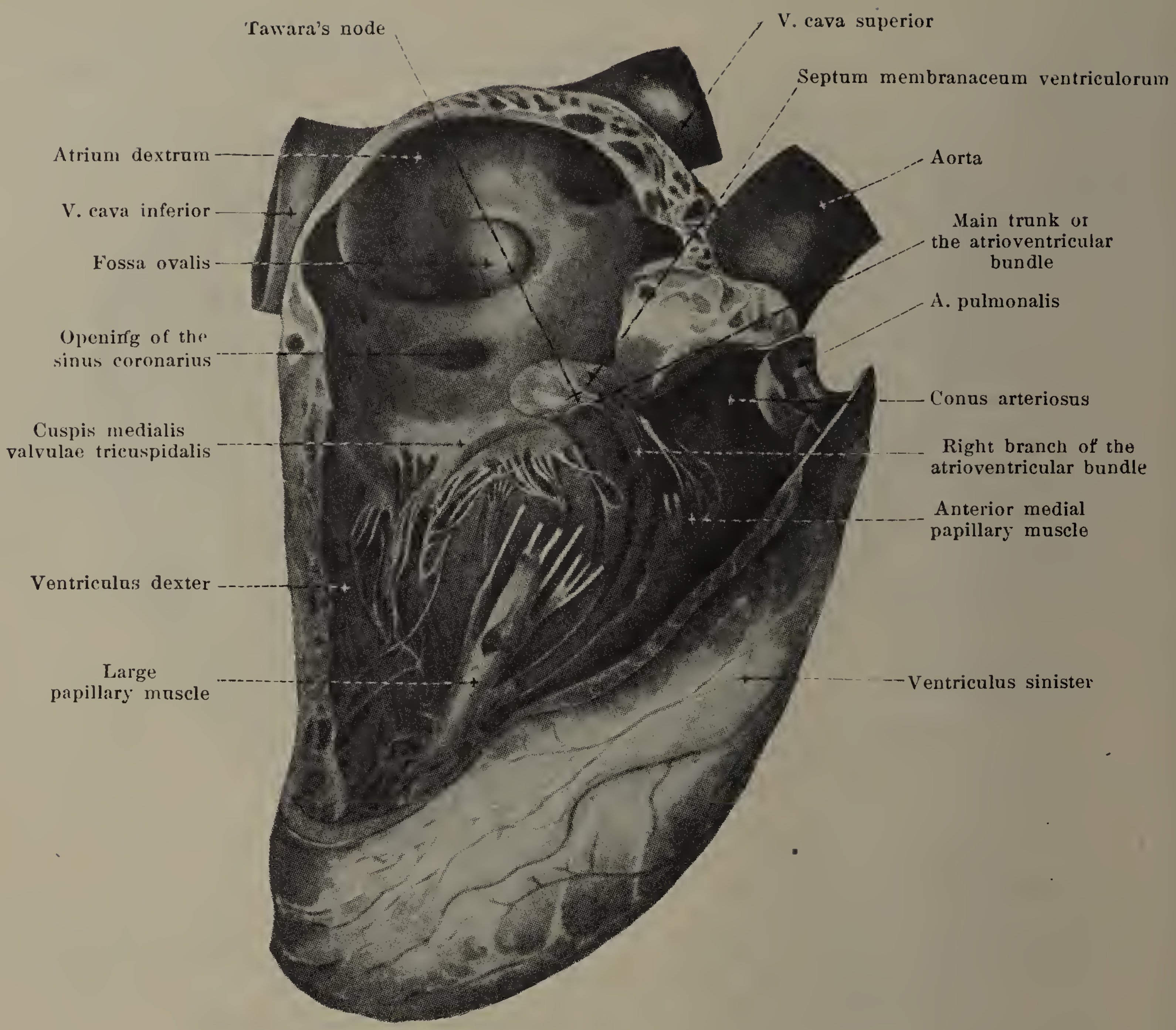
467. Course of the principal layers of muscle of the left ventricle of the heart,

viewed from below. Partly schematic.

(Parts of the wall of the heart have been removed above, on the left side below.)

The ***musculature of the ventricles*** (see also Figs. 464—466 and 468—470) is in its superficial layer common to both ventricles, but otherwise partly separated. The most superficial muscle layer ***(vortex fibres***, see Figs. 464, 465 and 470) arises in general from both annuli fibrosi and runs in slightly (left-)interwoven spiral turns (the fibres of the left ventricle usually more steeply than the fibres of the right ventricle) in front from the right and above downward and to the left, behind from the left and above downward and to the right. The layer is in general easily separable from its substratum. At the apex of the left ventricle the fibres converge and come to lie in layers ***(vortex cordis***, see also Fig. 464), bend sharply around into the interior of the left ventricle and become lost on the septal wall, in the papillary muscles and in the trabeculae carneae of the left chamber.

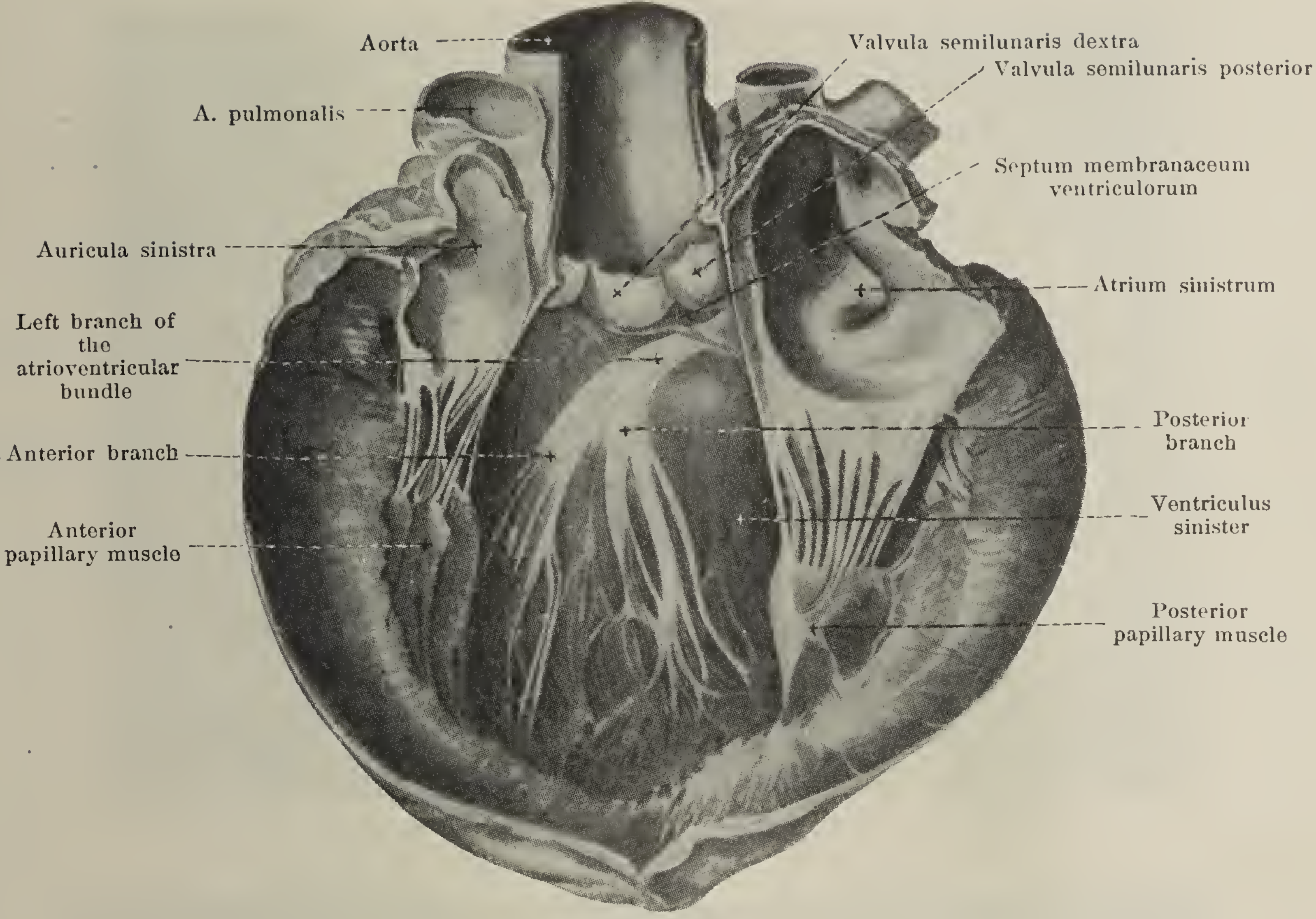
The ***musculature proper of the right ventricle*** (see also Figs. 464—466 and 468—470) is thin and shows in general two layers. The portion containing the ostium venosum shows, especially well marked in the dilated heart, an external, thin, continuous layer and an inner layer arranged more or less like a network. The fibres of the ***external*** layer arise from the posterior portions of both annuli fibrosi and between them, and run in the wall of the right ventricle forward in a direction similar to that taken by the vortex fibres, though less perpendicularly. Then a part of the fibres bends around sharply into the interior and mixes with the fibres of the inner layer (see below). Another part enters in front into the septal wall; these fibres are joined by fibres which surround the conus arteriosus in a ring-shaped manner. The *inner* layer is formed of short bands of fibres which arise partly at the upper margin of the septal wall, go toward the apex, turn at varying levels toward the external wall and run upward in this again, in part to end as the musculi papillares, in part to reach the annulus fibrosus as the ***trabeculae carneae;*** between these columns are others which are stretched out transversely. The conus arteriosus possesses on the inside of the mentioned layer of circular muscle a longitudinal layer at right angles to it; the latter forms longitudinal ridges in the contracted heart.


Tawara's node
V. cava superior
Septum membranaceum ventriculorum
Atrium dextrum
Aorta
V. cava inferior
Main trunk of the atrioventricular bundle
Fossa ovalis
A. pulmonalis
Opening of the sinus coronarius
Conus arteriosus
Cuspis medialis valvulae tricuspidalis
Right branch of the atrioventricular bundle
Anterior medial papillary muscle
Ventriculus dexter
Large papillary muscle
Ventriculus sinister

467ᵃ. The atrioventricular bundle and its distribution in the right ventricle.

(The wall of the atrium and of the ventricle has been partly removed. The atrioventricular bundle has been exposed by removal of the endocardium and of the muscle layer covering it.)

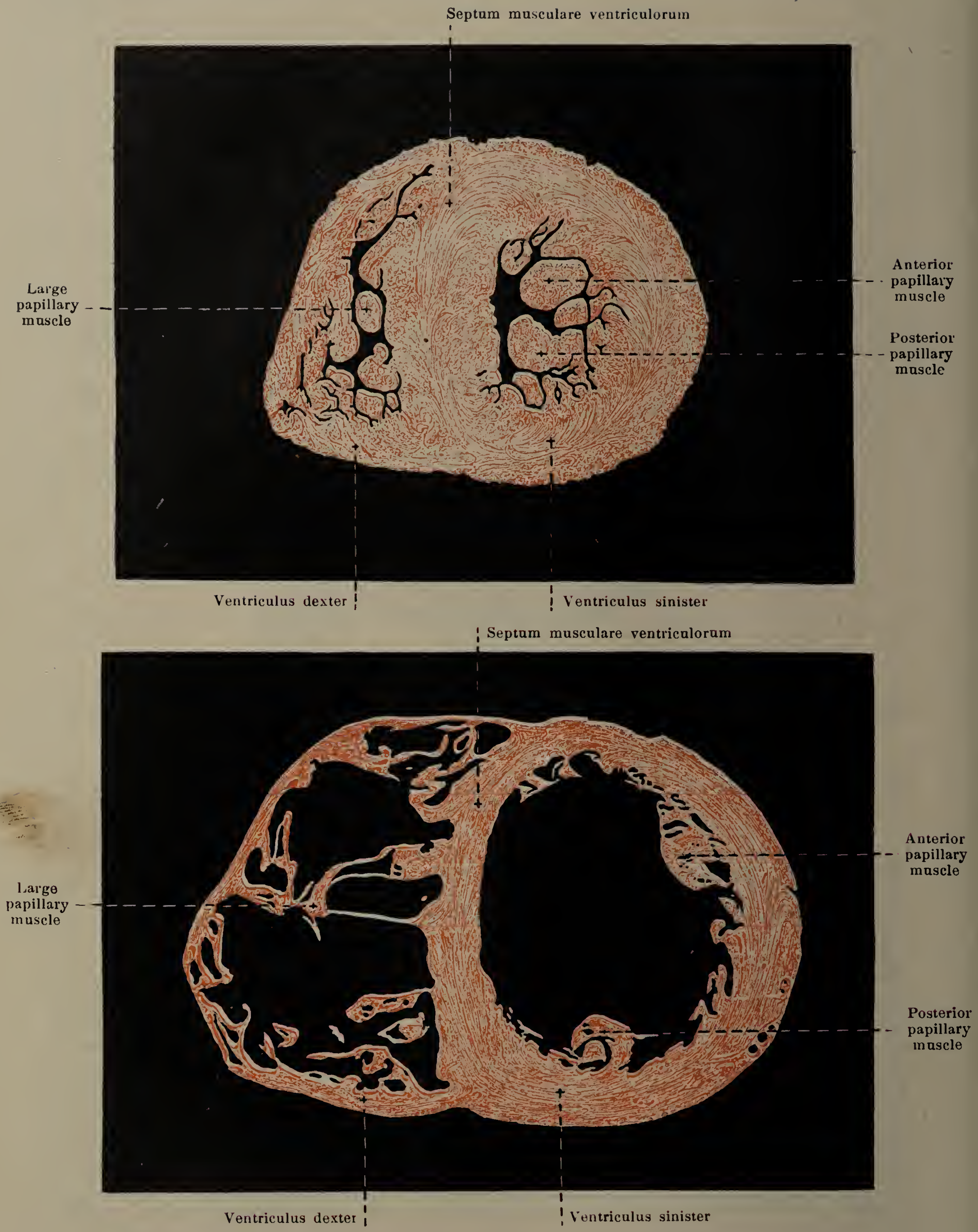
The *musculature of the left ventricle* is distinctly thicker than that of the right. Its fibres arise from the annulus fibrosus sinister and run downward (in layers and interwoven in slightly spiral turns) on the anterior, left and posterior surface of the left ventricle in a direction similar to that taken by the vortex fibres, though always less perpendicularly. Behind, the fibres enter into the septal wall and run forward in it. Then a part of them turns into the depth and bend around into the anterior papillary muscle; another part runs farther in the anterior and left ventricular wall and ascends partly in the posterior papillary muscle, partly alongside of it to the region of the trigonum fibrosum dextrum. Next to the external oblique fibres in the middle are those which are arranged approximately horizontally, that is, at right angles to the axis of the heart, and, next to these in the inner layer, are the fibres that run again obliquely, but in an opposite direction to the external (in right handed screw-like turns, that is in front from the right and below to the left and upward) (see Fig. 467). Thus, in general, the fibres leave the heart's apex free; this apex is thin-walled, and is formed only by the vortex fibres. The fibres, that run toward the base at the internal surface of the ventricle join the continuations of the vortex fibres (see page 389) and are arranged in gentle screw-like turns that run, however, nearly parallel to the long axis of the heart. Along with the papillary muscles they form as the *trabeculae carneae*, numerous long thick longitudinal ridges, which are united by thinner cross ridges to form a network. The septal wall below the ostium arteriosum is the only part that is completely smooth; upon it the left branch of the atrioventricular bundle (see p. 389ᵇ) runs downward.


Aorta
A. pulmonalis
Auricula sinistra
Left branch of the atrioventricular bundle
Anterior branch
Anterior papillary muscle
Valvula semilunaris dextra
Valvula semilunaris posterior
Septum membranaceum ventriculorum
Atrium sinistrum
Posterior branch
Ventriculus sinister
Posterior papillary muscle

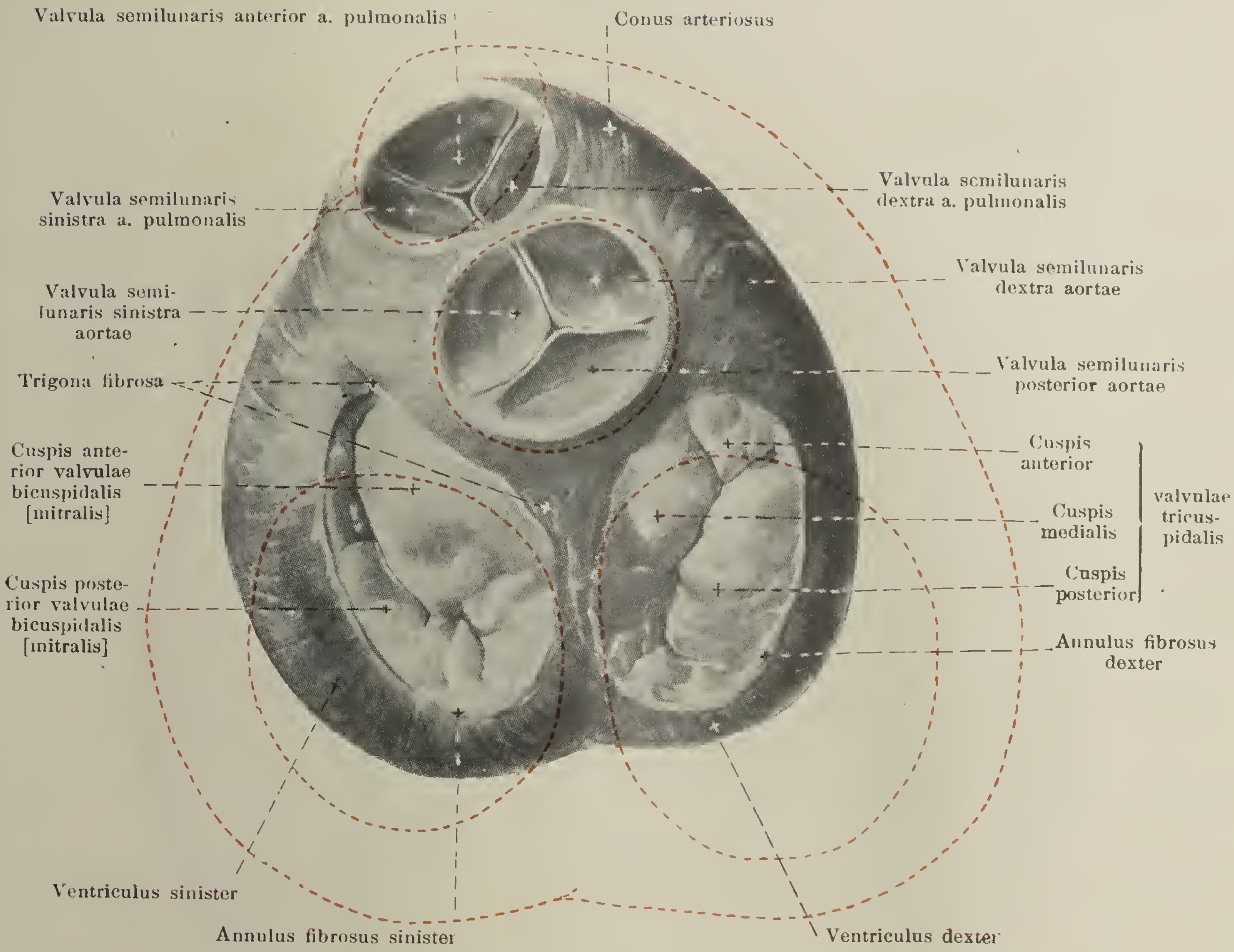
467b. The atrioventricular bundle and its distribution in the left ventricle.

(The left atrium and the left ventricle have been cut open and spread apart. The atrioventricular bundle has been exposed by removal of the endocardium.)

The musculature of the atria is connected with that of the ventricles only by means of a narrow bundle situated in the septal wall. This bundle is known as the *atrioventricular bundle* (see also Fig. 467a); it is a part of the *conduction system of the heart* and is composed of muscle fibres of a somewhat lighter color and of a slight yellowish tint. It begins a little in front of the opening of the sinus coronarius, close behind the septum membranaceum ventriculorum (see page 392), just above the upper, sharp margin of the septum musculare ventriculorum usually in a small thickening *(Tawara's node)*, into which radiate certain bands of uncertain origin derived from the atrial musculature (especially from the region below the opening of the sinus coronarius). The *trunk*, 1—2 mm. in thickness, of the bundle runs out of this node for a distance of about 1 cm. on the lower margin of the septum membranaceum along the edge of the septum musculare (displaced somewhat to the right); it runs forward and undergoes subdivision into a right and a left branch. The *right branch* runs, as a rounded bundle, in a curve that is slightly convex forward, on the right side of the ventricular septum. It extends downward, more or less hidden in the muscle mass, just behind the origin of the anterior medial papillary muscle (see p. 396) and enters the large trabecula carnea, which forms a bridge between the septal wall and the large papillary muscle. From this point on it cannot be followed further with the naked eye. The *left branch* extends downward and a little to the left, and, at the lower margin of the septum membranaceum beneath the point of attachment of the valvula semilunaris posterior aortae, reaches the left surface of the ventricular septum, passes obliquely downward and forward upon it as a broad but very thin band of fine fibres, and then divides, while still in the upper third of the ventricular septum, into two branches. Of these two branches, the anterior splits up and passes to the trabeculae, which extend to the base of the anterior papillary muscle; the posterior, bending a little downward, similarly reaches the base of the posterior papillary muscle; a few fibres are split off and become lost in the rest of the trabecular network. The left branch with all its visible branches lies close beneath the endocardium and is partly visible through it.


Septum musculare ventriculorum
Large papillary muscle
Anterior papillary muscle
Posterior papillary muscle
Ventriculus dexter
Ventriculus sinister
Septum musculare ventriculorum
Large papillary muscle
Anterior papillary muscle
Posterior papillary muscle
Ventriculus dexter
Ventriculus sinister

468 and 469. Cross-sections of two hearts
between the upper and middle third of the ventricles, perpendicular to the long axis, seen from the apical side.
The upper heart has been fixed in systole, the lower in diastole. (After L. v. Krehl.)


Valvula semilunaris anterior a. pulmonalis
Conus arteriosus
Valvula semilunaris sinistra a. pulmonalis
Valvula semilunaris dextra a. pulmonalis
Valvula semilunaris dextra aortae
Valvula semilunaris sinistra aortae
Trigona fibrosa
Valvula semilunaris posterior aortae
Cuspis anterior valvulae bicuspidalis [mitralis]
Cuspis anterior
Cuspis medialis
Cuspis posterior
valvulae tricuspidalis
Cuspis posterior valvulae bicuspidalis [mitralis]
Annulus fibrosus dexter
Ventriculus sinister
Annulus fibrosus sinister
Ventriculus dexter

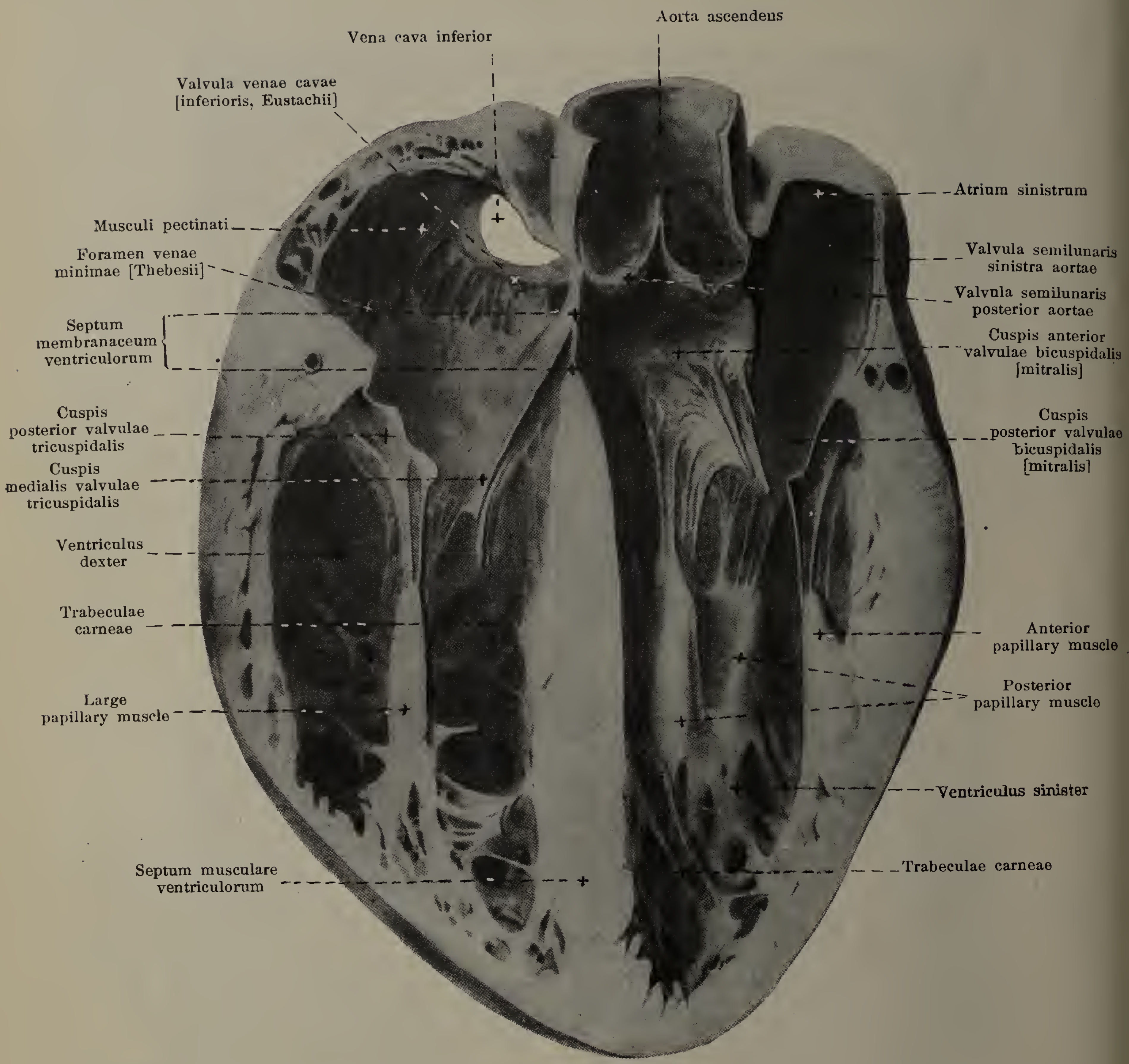
470. Base of the contracted ventricles,
after removal of the fore-chambers. The valves are closed.
(The outlines of the distended ventricles are indicated in red, the position of the ostium arteriosum sinistrum being assumed to be fixed.)

The **annuli fibrosi** are dense, narrow bands of connective tissue, which surround the ostia venosa at the base of the ventricles. They serve for the attachment of the muscular fibres of the atria and of the ventricles, and from them arise in largest part the valvulae tricuspidalis and bicuspidalis. The right surrounds the ostium venosum dextrum in the form of an oval closed ring. The left is horse-shoe-shaped surrounding the right, inferior and left sides of the ostium venosum sinistrum; it begins right and left at the root of the aorta in a nodular thickening on either side, the *trigonum fibrosum;* between these the anterior cusp of the valvula bicuspidalis arises directly from the membranous wall of the root of the aorta.

The **differences between** the **contracted** and **dilated ventricles** are as follows (see also Figs. 462—465, 468 and 469):

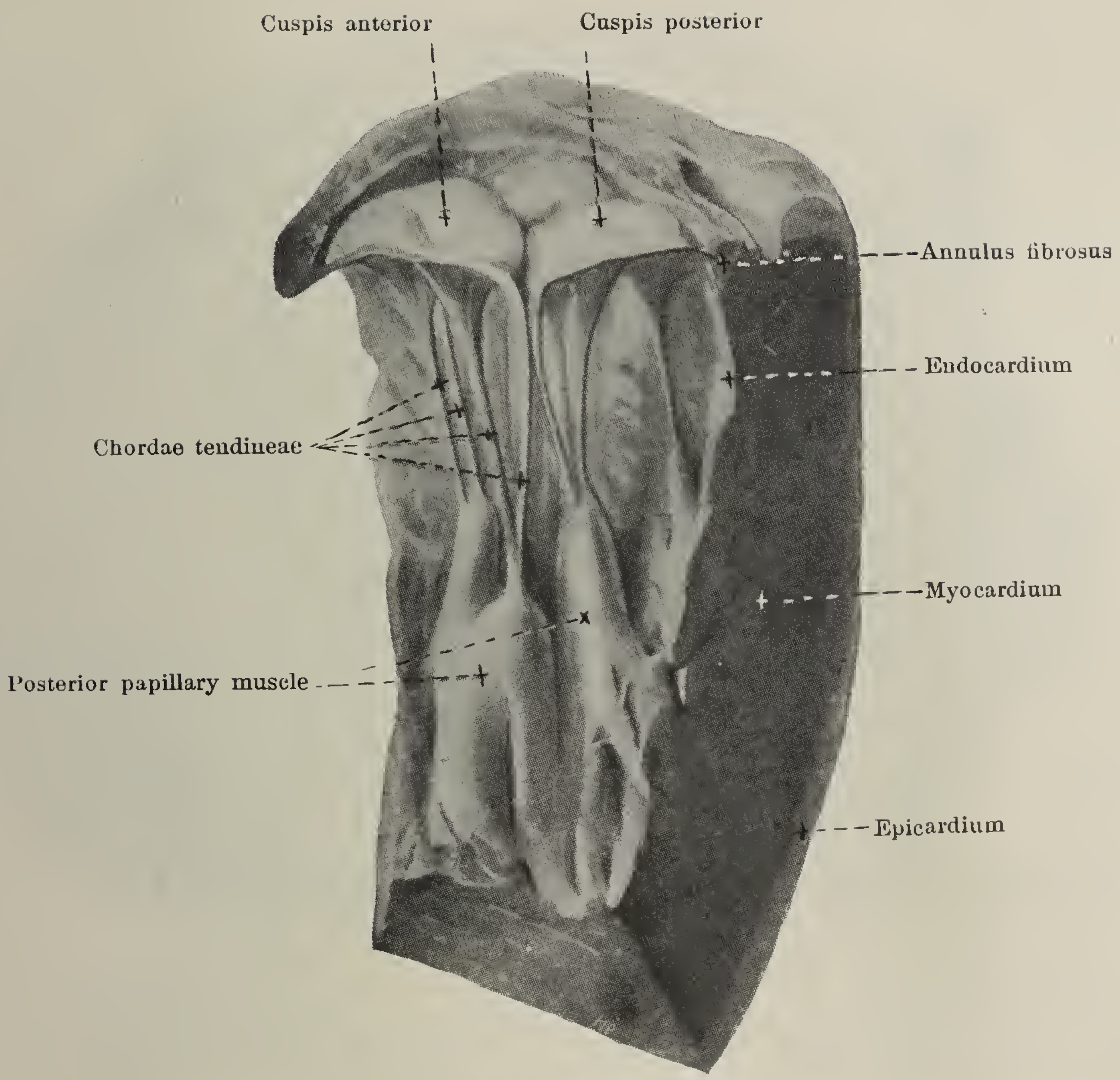
In the *dilated ventricles* the diameter of the base is nearly the same as that of the long axis; the form approaches that of a hemisphere. The conus arteriosus projects somewhat, the lower surface in its left section projects distinctly convex and shows in the middle and in its right section a furrow-shaped shallow depression, particularly marked toward the apex; the ostia venosa and arteriosa are large, the cavities of the ventricles are wide open; the trabeculae carneae extend partly through the lumen of the ventricles, and the musculi papillares stand out partly free in the ventricular cavities.

On maximal *contraction of the ventricles*, the diameters of the base are markedly shortened, while that of the long axis diminishes only slightly; the form is wedge-shaped. The conus arteriosus shortens and sinks in; the facies diaphragmatica bulges throughout slightly convexly, and the furrow-shaped depression in the dilated heart is still perceptible only at the level of the apex slightly bent downward; the sulcus longitudinalis anterior has a more marked spiral twist, the ostia venosa are markedly diminished in size, the ostia arteriosa less markedly, the cavities of the ventricles are represented only by a slit (with the exception of a space situated above the apices of the papillary muscles); the trabeculae carneae and the musculi papillares lie close to the walls and form ridge-like projections.


Aorta ascendens
Vena cava inferior
Valvula venae cavae [inferioris, Eustachii]
Musculi pectinati
Foramen venae minimae [Thebesii]
Septum membranaceum ventriculorum
Cuspis posterior valvulae tricuspidalis
Cuspis medialis valvulae tricuspidalis
Ventriculus dexter
Trabeculae carneae
Large papillary muscle
Septum musculare ventriculorum
Atrium sinistrum
Valvula semilunaris sinistra aortae
Valvula semilunaris posterior aortae
Cuspis anterior valvulae bicuspidalis [mitralis]
Cuspis posterior valvulae bicuspidalis [mitralis]
Anterior papillary muscle
Posterior papillary muscle
Ventriculus sinister
Trabeculae carneae

471. Transverse section through a distended heart
approximately parallel to the facies diaphragmatica.
(Inferior half of the section, viewed from above.)

The **septum ventriculorum** *(interventricular septum)* (see also Figs. 466, 468 and 469) separates the two ventricles from one another completely. It is muscular in by far its largest part *(septum musculare ventriculorum)*, is formed by a corresponding portion of the musculature of each of the two ventricles and can be divided into its two components only by artificial means. On contraction it thickens and the distance between the two sulci longitudinales diminishes. The ***septum membranaceum ventriculorum*** (O. T. undefended space) is a small area of pure connective tissue situated in the region of the atria. Its left surface is situated just between and in front of the opposed margins of the valvulae semilunares dextra et posterior aortae (see also Figs. 467^{a}, 467^{b} and 477); its right surface is divided into two parts by the cuspis medialis valvulae tricuspidalis arising from it; the posterior part looks into the right atrium, the anterior into the right ventricle. About the relations of the septum membranaceum to the atrioventricular bundle see p. 389^{b}.



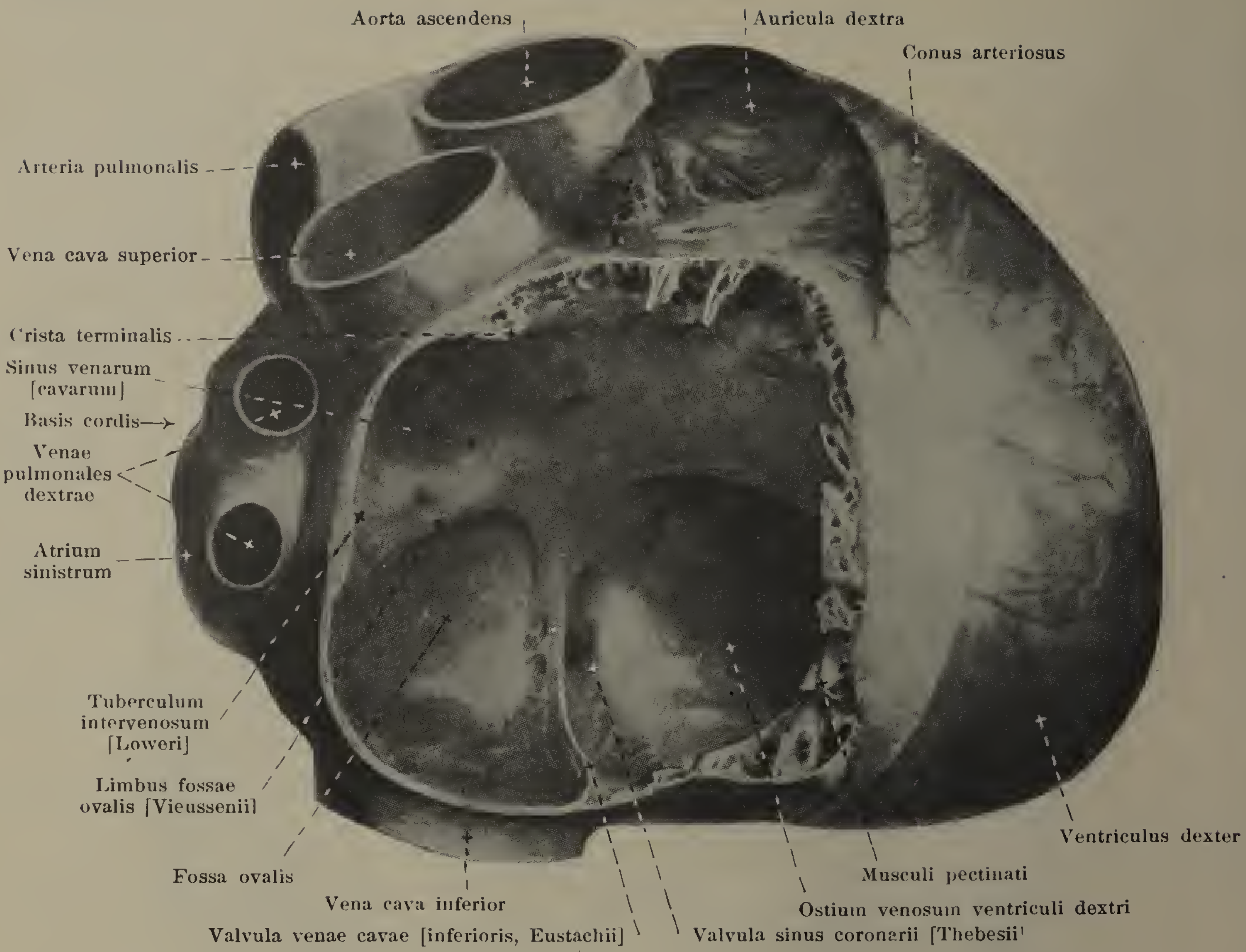
472. Transverse section through the valvula bicuspidalis [mitralis].

The valve is set.

(Inferior half, viewed from above.)

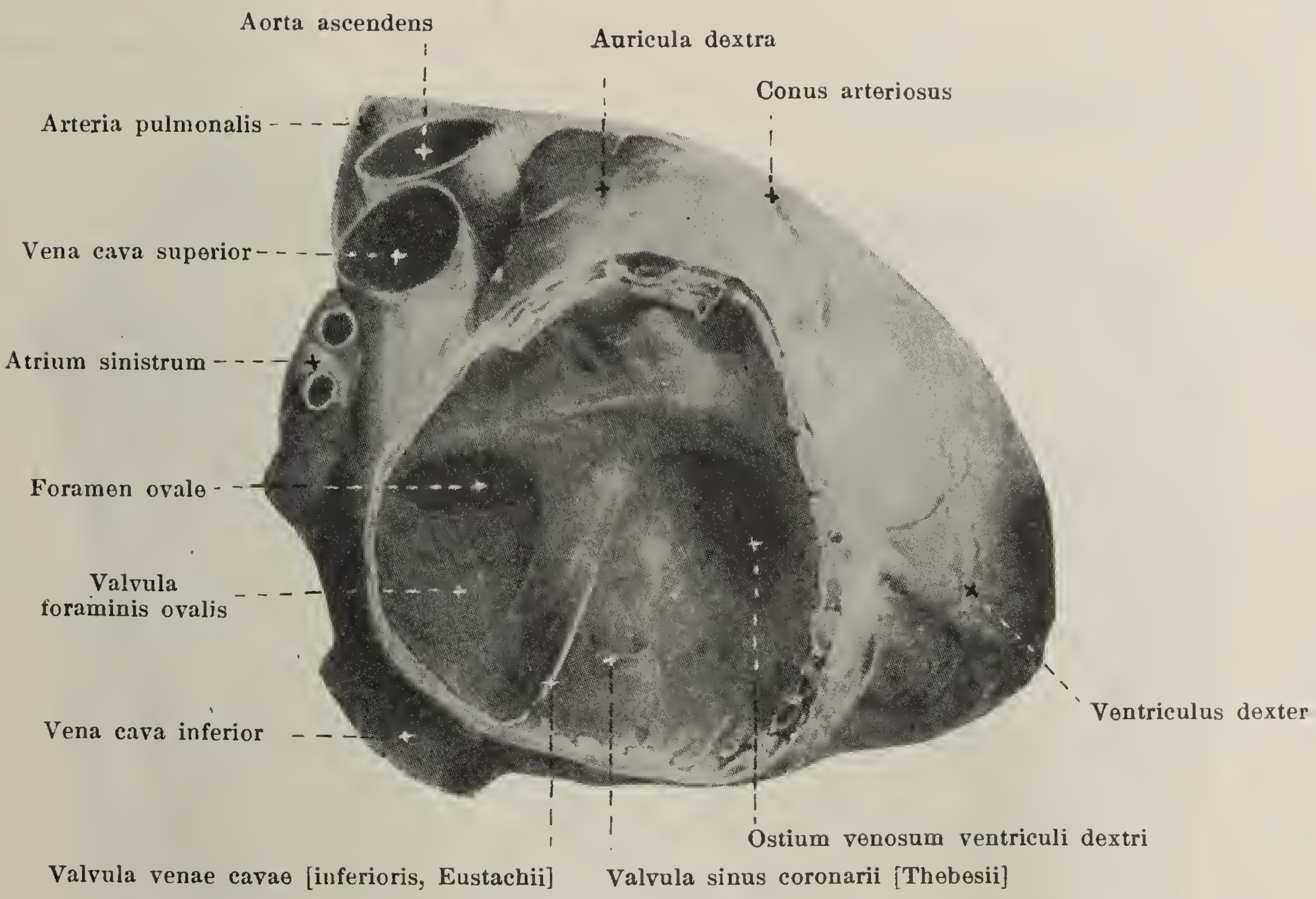
The **musculi papillares** *(papillary muscles)* (see also Figs. 468, 469, 471, 475 and 476) are more or less isolated, bluntly wedge-shaped elevations of the internal muscular layer of the ventricles. They vary much in size and in different hearts present considerable differences in appearance. From the tip of each muscle there go off one or several tendinous threads *(chordae tendineae)* of variable strength, which become attached partly to the free margins (chordae tend. of the I order), partly to the ventricular surface (chordae tend. of the II order) of the cusps of the valves guarding the ostia venosa; the insertion is in the form of a triangular flat expansion. Each papillary muscle gives off chordae usually to two adjacent cusps. In addition other tendinous threads (chordae tend. of the III order) arise directly from the musculature of the ventricles near to the peripheral margin of the valves and become attached in the same way also to the ventricular surface of the cusps. The chordae tendineae are of unequal length and are so arranged that the valve is set when they are all put upon the stretch, and vice versa.

The *valvula tricuspidalis* and *valvula bicuspidalis [mitralis]* (see also Figs. 470 and 471) consists each of a tube-like membrane, which is attached to the annulus fibrosus (also partly to the wall of the root of the aorta on the left side) and is divided at its free margin by deep incisures into large *sails* or *cusps (cuspides)* and by less deep incisures into variably developed, smaller, intermediary cusps. They are covered on both sides by endocardium, contain in their peripheral third external circular and internal radial muscle fibres which are connected with the musculature of the fore-chambers (see p. 388) and possess in this part also vessels. At the end of the diastole of the ventricles, the central portions of the atrial surfaces of the cusps become applied to one another (the valves become set); the closure is water-tight and during the systole becomes gradually ever more complete, since the ostia venosa are markedly diminished in size, and thus ever larger sections of the cusps of the valves are applied to one another.



473. Right fore-chamber *(atrium dextrum)*
of a markedly distended adult heart, viewed from the right.
(A part of the wall of the atrium has been removed.)

The **atrium dextrum** *(right fore-chamber,* O. T. right auricle) (see also Figs. 462—465 and 471) is of the shape of an irregular short cylinder. A groove, variably developed, running perpendicularly over the posterior external surface, the *sulcus terminalis atrii dextri,* and a ridge on the corresponding spot of the inner wall, the *crista terminalis,* mark off a posterior, medial portion, the *sinus venarum [cavarum],* which is derived from the right horn of the sinus reuniens of the embryonic heart (see also p. 402). It contains in its lower and upper walls the mouths of the vv. cavae superior and inferior and in general has smooth walls. Between the opening of the v. cava inferior and the sulcus coronarius to the left of the sulcus terminalis there is often visible on its outer surface an irregular lumpy projection *(appendix auricularis posterior)* (see Fig. 463). The posterior wall of the sinus is bounded partly by the atrium sinistrum, being slightly shoved forward by the same and presents there a transverse ridge, the *tuberculum intervenosum [Loweri]* (O. T. tubercle of Lower). The left wall is formed by the *septum atriorum* (O. T. interauricular septum), which consists partly of muscle, partly *(pars membranacea septi atriorum)* of pure connective tissue. The latter spot lies in the lower part of the wall, is somewhat deepened *(fossa ovalis)* and is surrounded in front, above and behind by a strong ridge of muscle *(limbus fossae ovalis [Vieussenii]).* Starting at the anterior limb of the limbus, and arising from the inferior wall, is a thin, often partially perforated, fold of connective tissue which surrounds the mouth of the v. cava inferior from in front and sometimes also from the right, *valvula venae cavae [inferioris, Eustachii]* (O.T. Eustachian valve). Just in front of it, in the angle between the inferior, left and anterior walls, lies the mouth of the sinus coronarius; it is only imperfectly closed from below by the sickle-shaped *valvula sinus coronarii [Thebesii]* (O. T. coronary valve or valve of Thebesius), which is often perforated. The anterior wall of the atrium contains the ostium venosum of the right ventricle. The right wall presents numerous muscular ridges projecting on the inner surface *(musculi pectinati)* (see also Fig. 471); these arise from the crista terminalis and extend approximately in the direction of the long axis of the heart as far as the sulcus coronarius; between them at the dilated heart the wall is translucent.



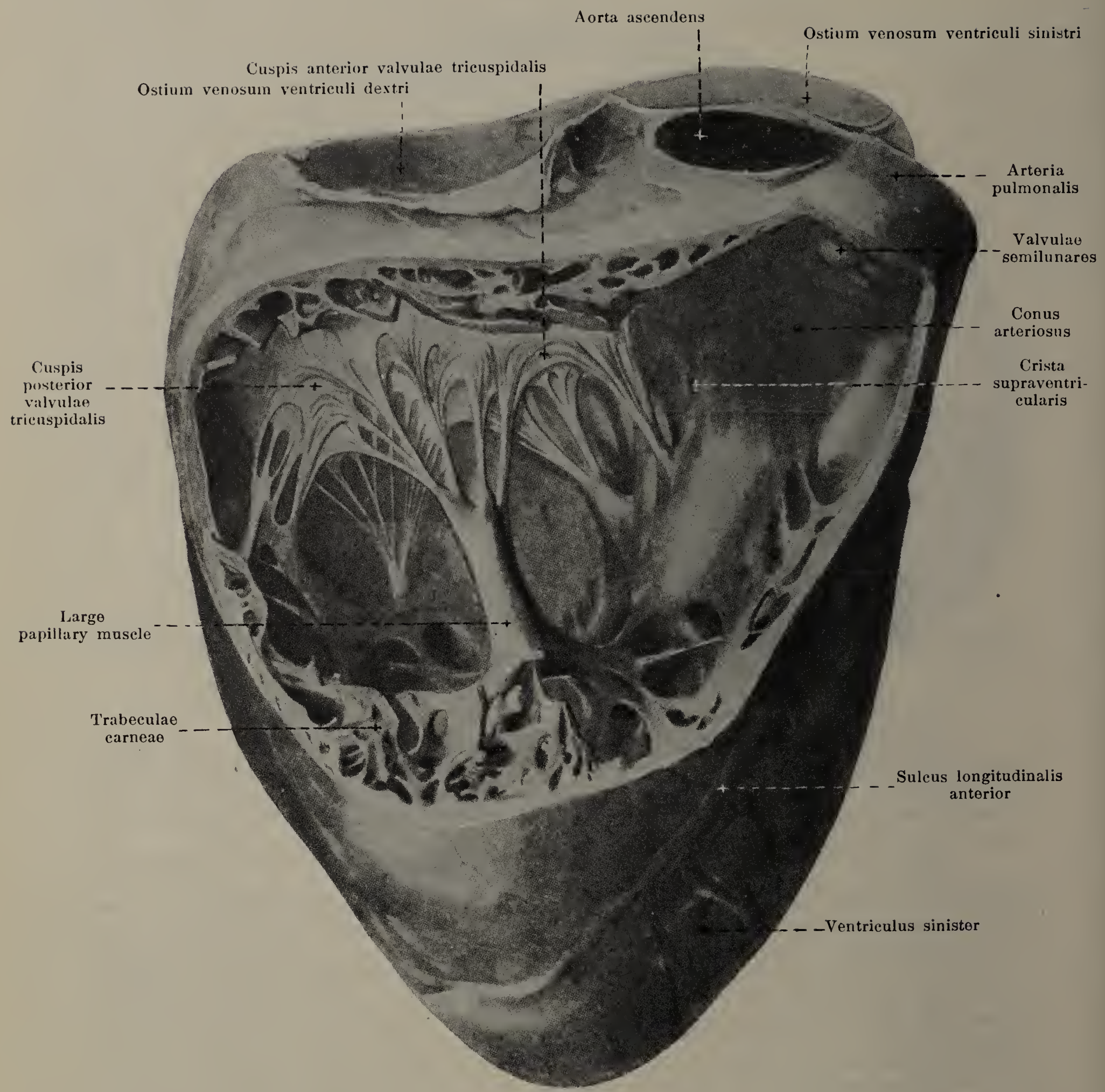
474. Right fore-chamber ***(atrium dextrum)*** **of a fetal heart** (8th month), viewed from the right.

(A part of the wall of the atrium has been removed. Magnification: 2 : 1.)

Atrium dextrum (continued). From the upper wall projects the bluntly wedge-shaped *auricula dextra (right auricle of the heart)* (O. T. right auricular appendix). It curves around the first portion of the aorta ascendens to the left, is slightly notched above and below but otherwise smooth; it presents inside numerous irregular crossing muscular columns, *trabeculae carneae.*

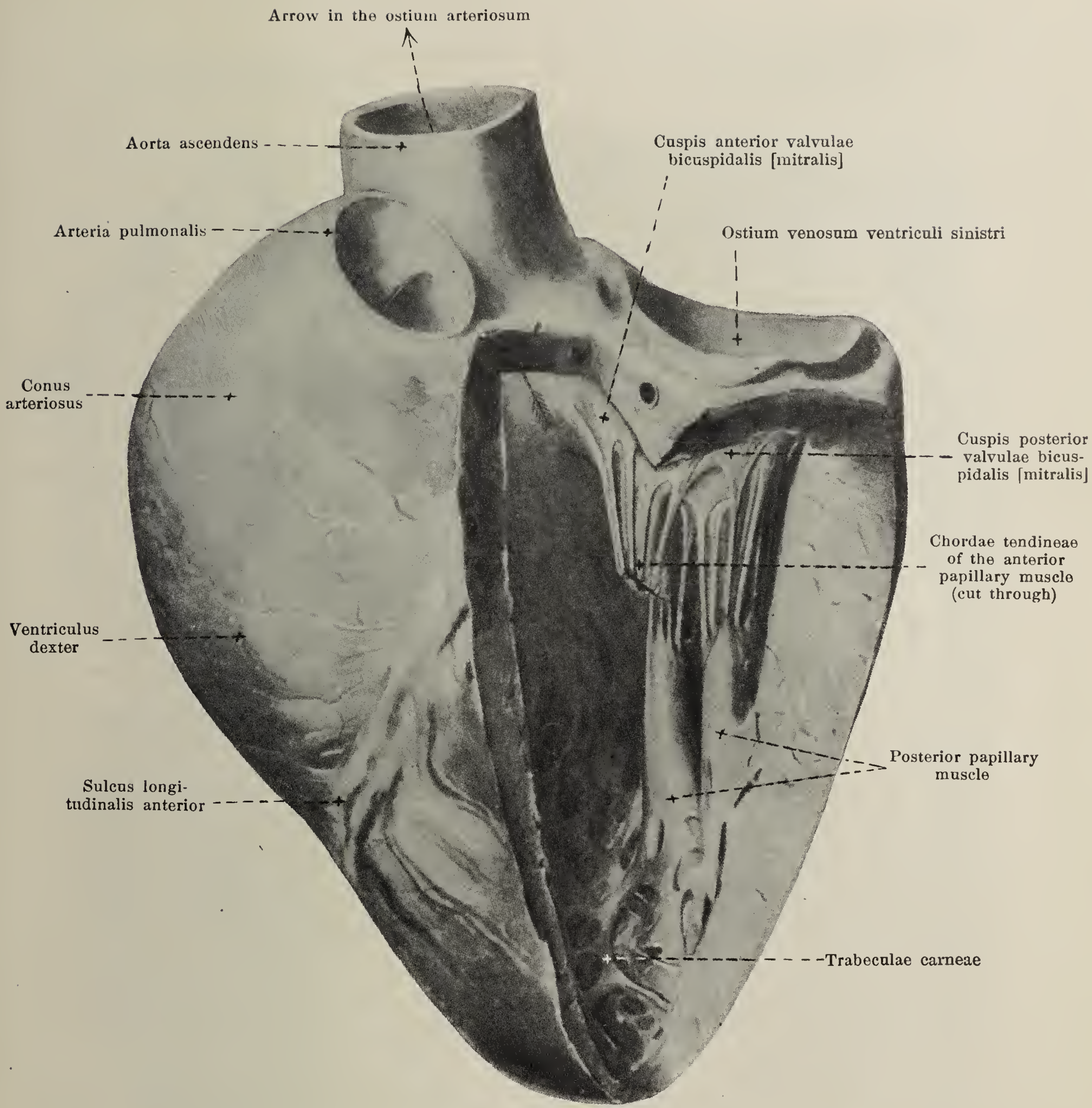
During fetal life the two atria communicate with one another through an opening, the *foramen ovale,* situated at the spot which later is the fossa ovalis. At its margin in front and above it is surrounded by a horse-shoe-shaped, powerful band of muscle, which later becomes the limbus fossae ovalis, and behind and below it is bounded by the *valvula foraminis ovalis* which rises as a thin connective tissue plate from behind and below and projects, groove-like, into the left atrium. Just after birth, as soon as the pressure in the left atrium becomes higher than in the right, this valve is pressed upon the limbus and fuses with it almost completely, occasionally, however, leaving a small capillary slit open. The valvula foraminis ovalis becomes accordingly later the floor of the fossa ovalis; the anterior concave margin of the valve is often retained and is visible inside the left atrium on the septal surface (see p. 397).

The **ventriculus dexter** *(right ventricle)* (see Figs. 462—466, 468—471 and 475) has the shape of a wedge; its left concave surface is attached to the right side of the left ventricle; its apex does not reach the apex of the heart. The base of the wedge is hidden by the attachment of the right atrium; the inferior, the right and the superior anterior surfaces lie free; the latter goes very gradually over into the arteria pulmonalis, and in the distended heart projects markedly convexly forward *(conus arteriosus).* On the inside, marking off the conus arteriosus from the rest (the venous portion) of the ventricle, is a muscular projection *crista supraventricularis)* which extends, arch-like, from the chamber-base, to the anterior medial papillary muscle (see p. 396) or passes a little before it; a slight ridge, which extends from the region immediately behind this papillary muscle on the septum in the direction to the apex, to the roots of the great papillary muscle, contains the continuation of the right limb of the atrioventricular bundle (see p. 389b). The venous portion presents at the septum a fairly smooth wall, but elsewhere very many trabeculae carneae (see p. 389). The *ostium venosum* can be closed by the *valvula tricuspidalis (tricuspid valve);* this presents (see Fig. 470) a large cusp adjoining the interventricular septum *(cuspis medialis),* further a small *cuspis anterior* corresponding about to the conus arteriosus, a large *cuspis posterior* turned toward the right free wall, and, usually, between the cuspis medialis and cuspis posterior an additional small intermediary cusp.


Aorta ascendens
Ostium venosum ventriculi sinistri
Cuspis anterior valvulae tricuspidalis
Ostium venosum ventriculi dextri
Arteria pulmonalis
Valvulae semilunares
Conus arteriosus
Crista supraventricularis
Cuspis posterior valvulae tricuspidalis
Large papillary muscle
Trabeculae carneae
Sulcus longitudinalis anterior
Ventriculus sinister

475. Right ventricle *(ventriculus dexter)*
of a markedly distended heart, viewed from the right and above.
(The largest part of the right and anterior wall has been removed; the atria have been removed.)

Ventriculus dexter (continued). The chordae tendineae of the anterior and posterior cusps come partly from a large papillary muscle which stands up free from among the trabeculae carneae below the junction of the conus arteriosus with the venous portion; besides this there is usually one smaller (posterior medial) papillary muscle between the septum and the inferior (diaphragmatic) wall, as well as one very small (anterior medial) between the anterior and medial cusp on the septum just below the crista supraventricularis (see p. 395), in whose place several papillary muscles always can be found; the medial cusp receives many chordae directly from the septum itself. The papillary muscles of the right ventricle present marked individual variations. The conus arteriosus is more tubular, has a fairly smooth wall and goes over through the *ostium arteriosum* into the a. pulmonalis; at the entrance to the latter are situated the *valvulae semilunares arteriae pulmonalis anterior, dextra, sinistra* (semilunar valves of the pulmonary artery) (see p. 398).

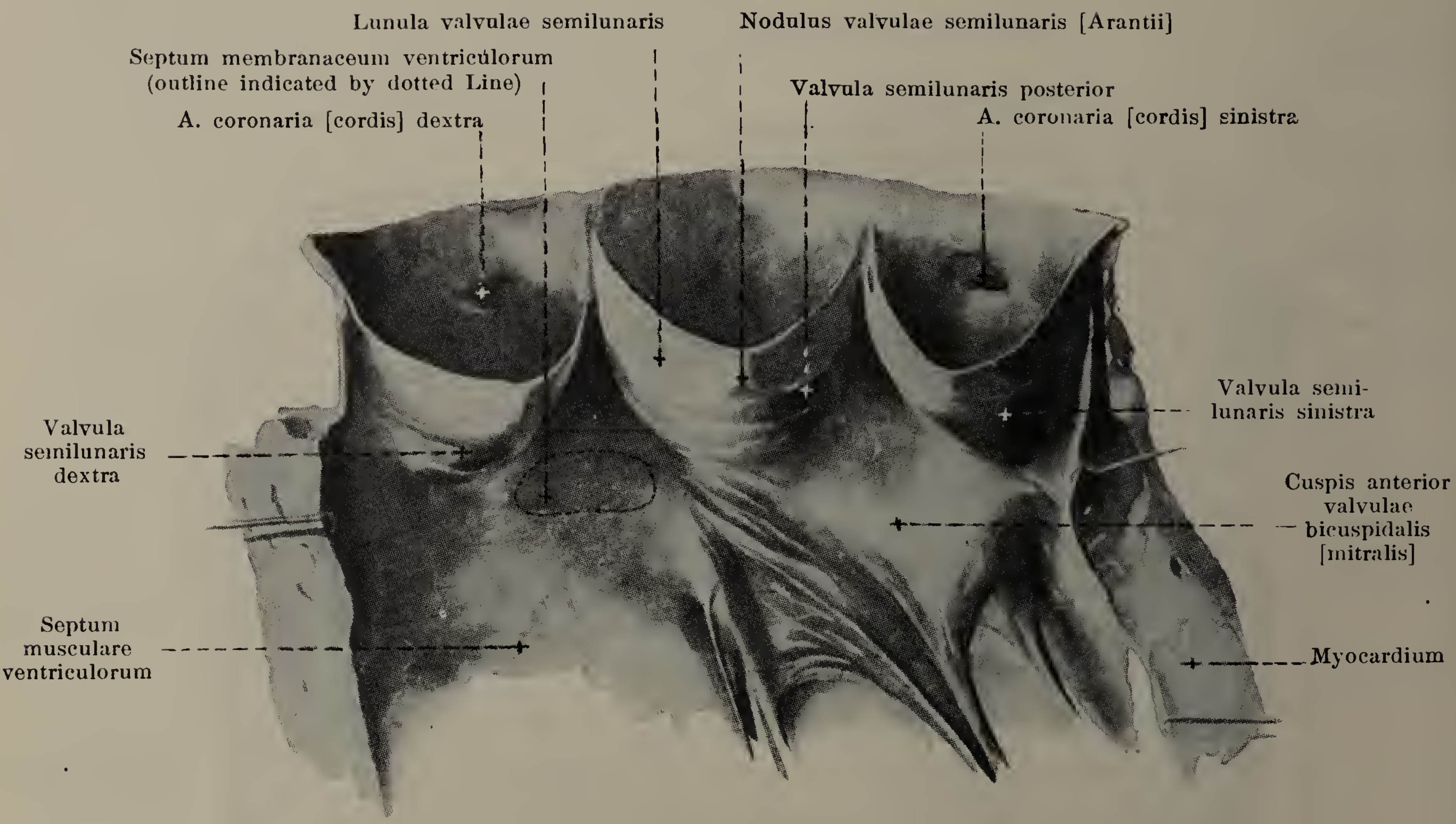

Arrow in the ostium arteriosum
Aorta ascendens
Arteria pulmonalis
Conus arteriosus
Ventriculus dexter
Sulcus longitudinalis anterior
Cuspis anterior valvulae bicuspidalis [mitralis]
Ostium venosum ventriculi sinistri
Cuspis posterior valvulae bicuspidalis [mitralis]
Chordae tendineae of the anterior papillary muscle (cut through)
Posterior papillary muscle
Trabeculae carneae

476. Left ventricle *(ventriculus sinister)*

of a distended heart, viewed from in front and somewhat from the left.

(The anterior wall of the left ventricle has been almost entirely removed, the left wall partially and with them also the anterior papillary muscle; the atria have been cut away. A arrow has been introduced into the ostium arteriosum.)

The **atrium sinistrum** *(left fore-chamber)* (O. T. left auricle) (see Figs. 462—465 and 478), is wedge-shaped, broad behind, narrower in front. At the junction of the posterior with the lateral surfaces, right and left, lie the openings of the venae pulmonales. The right wall, formed partly by the septum atriorum, shows frequently the concave margin of the *valvula foraminis ovalis* (see p. 395). The anterior wall contains the ostium venosum ventriculi sinistri. From the junction of the right with the superior wall goes off the zigzag-curved *auricula sinistra (left auricle of the heart)* (O. T. left auricular appendix) which curves around the a. pulmonalis from the left and reaches as far as its anterior surface. This left auricular appendix contains inside it numerous interlacing *trabeculae carneae;* otherwise the wall of the atrium is smooth inside.


Lunula valvulae semilunaris
Nodulus valvulae semilunaris [Arantii]
Septum membranaceum ventriculorum (outline indicated by dotted Line)
Valvula semilunaris posterior
A. coronaria [cordis] dextra
A. coronaria [cordis] sinistra
Valvula semilunaris dextra
Valvula semilunaris sinistra
Cuspis anterior valvulae bicuspidalis [mitralis]
Septum musculare ventriculorum
Myocardium

477. Valvulae semilunares aortae, opened up.

(The left ventricle and the aorta have been opened by a cut passing between the right and the left valve; the walls have been spread apart.)

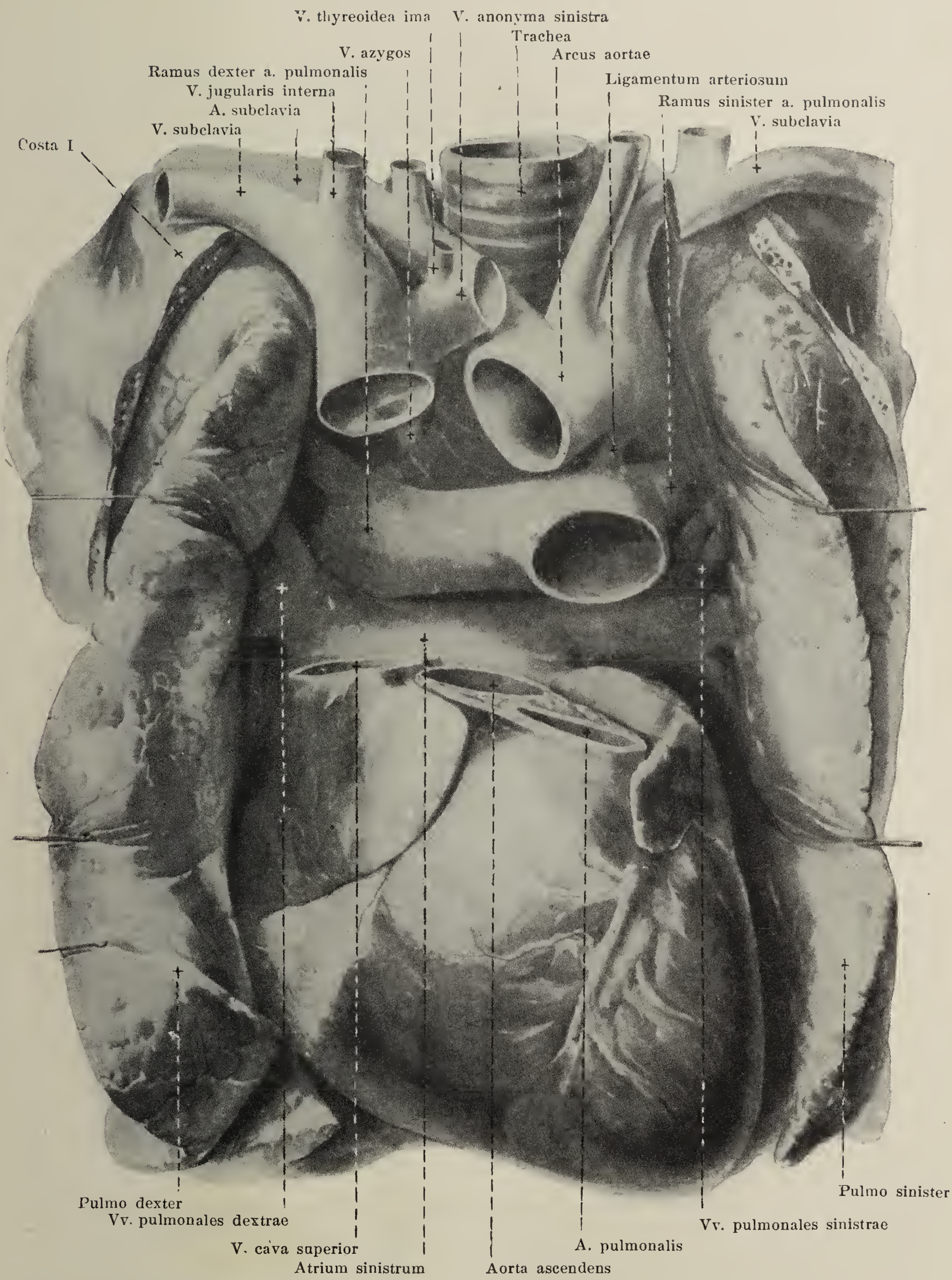
The **ventriculus sinister** *(left ventricle)* (see Figs. 462—472 and 476) has the shape of an egg, the large end of which is directed toward the right and backward and contains the ostia venosum et arteriosum; the other end forms the apex of the heart. As regards the inner surface see also p. 389^a. The *ostium venosum* is guarded by the *valvula bicuspidalis [mitralis] (biscupid* or *mitral valve).* This consists of two large cusps and usually two small intermediary cusps; of the larger cusps, the *cuspis anterior,* situated to the left and behind, arises from the annulus fibrosus sinister; the *cuspis anterior,* situated to the right and in front, comes however only partially from the annulus fibrosus sinister, having its origin chiefly from that connective tissue portion of the root of the aorta which extends between the trigona fibrosa, so that the ventricular surface of this cusp goes over directly into this part of the wall of the aorta (see also Figs. 471 and 476). The chordae tendineae come from two papillary muscles, an anterior and a posterior one, each of which can in turn be divided into several wedges; both muscles are developed from the left wall and correspond in their position approximately to the *sinistra, posterior;* the posterior portion of the left valve and the left portion of the posterior valve arise from the membranous part, the other parts of these valves and the right valve from the muscular part of the root of the aorta.

Each *valvula semilunaris* presents just below the middle of its concave, free margin a small nodular thickening, *nodulus valvulae semilunaris [Arantii],* and on both sides of this, near the margin, a sickle-shaped, thinner portion, *lunula valvulae semilunaris,* by means of which it lies against the neighboring valve.

The small or **pulmonary circulation** consists of the a. pulmonalis, the vv. pulmonales and their branches.

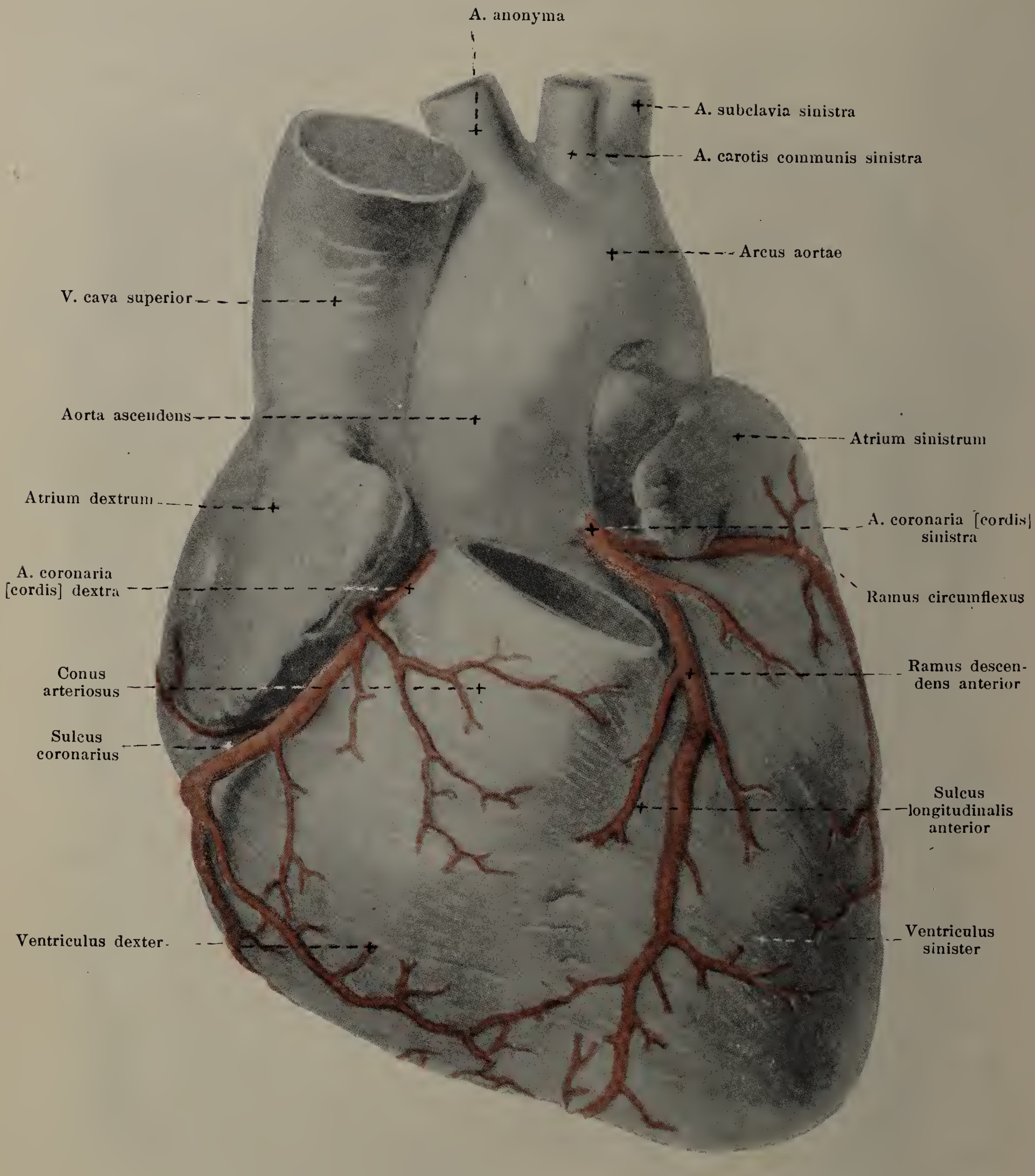
The **a. pulmonalis** (see Figs. 462—464, 478, 680 and 681) extends on the left side of the aorta ascendens obliquely to the left and backward and divides below the arcus aortae into a *ramus dexter* and a *ramus sinister.* The former goes below the arcus aortae behind the aorta ascendens and v. cava superior, in front of the bronchus dexter to the hilus of the right lung; the r. sinister runs in front of the bronchus sinister and the aorta thoracalis to the left lung. In the prolongation of the main stem a band of elastic-connective tissue, the *ligamentum arteriosum,* the remains of the obliterated ductus arteriosus [Botalli], extends to the concave, anterior wall of the end of the arcus aorta (see p. 491).

The **vv. pulmonales** (see Figs. 478, 671, 672, 680 and 681) come from the hilus pulmonalis on each side and open into the atrium sinistrum. They run on both sides in front of the main branches of the a. pulmonalis and in front of the bronchi; in addition the right veins go behind the v. cava superior and the atrium dextrum, the left in front of the aorta thoracalis.



478. Position of the great vessels, viewed from in front.

(Pieces have been cut out of the v. cava superior, aorta and a. pulmonalis; the heart has been turned downward, so that the apex looks downward.)

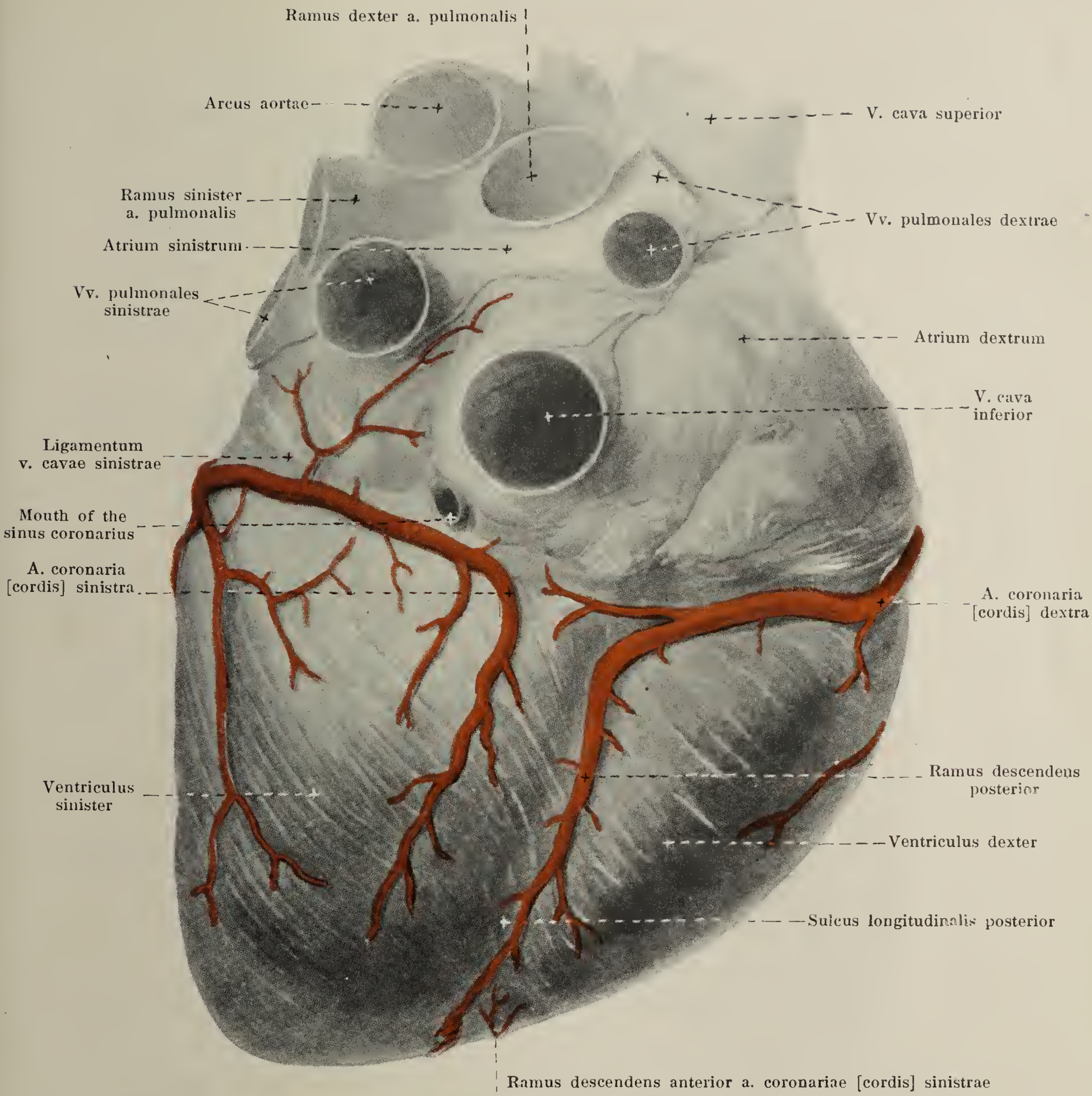


479. The arteries of the heart,

viewed from above and in front.

(The ostium arteriosum dextrum and the a. pulmonalis have been removed.)

The a. **coronaria [cordis] dextra** *(right coronary artery)* (see also Fig. 480) arises in the right sinus aortae [Valsalvae] (see Figs. 477 and 484), runs at first between the right auricular appendix and the conus arteriosus, then in the sulcus coronarius first to the right and then upon the facies diaphragmatica to the left; finally it bends around into the sulcus longitudinalis posterior and, as the ***ramus descendens posterior***, arrives close to the apex of the heart. It gives off large branches to the right ventricle, small branches to the right atrium and (from the r. descendens posterior) to the left ventricle and to the septum ventriculorum.

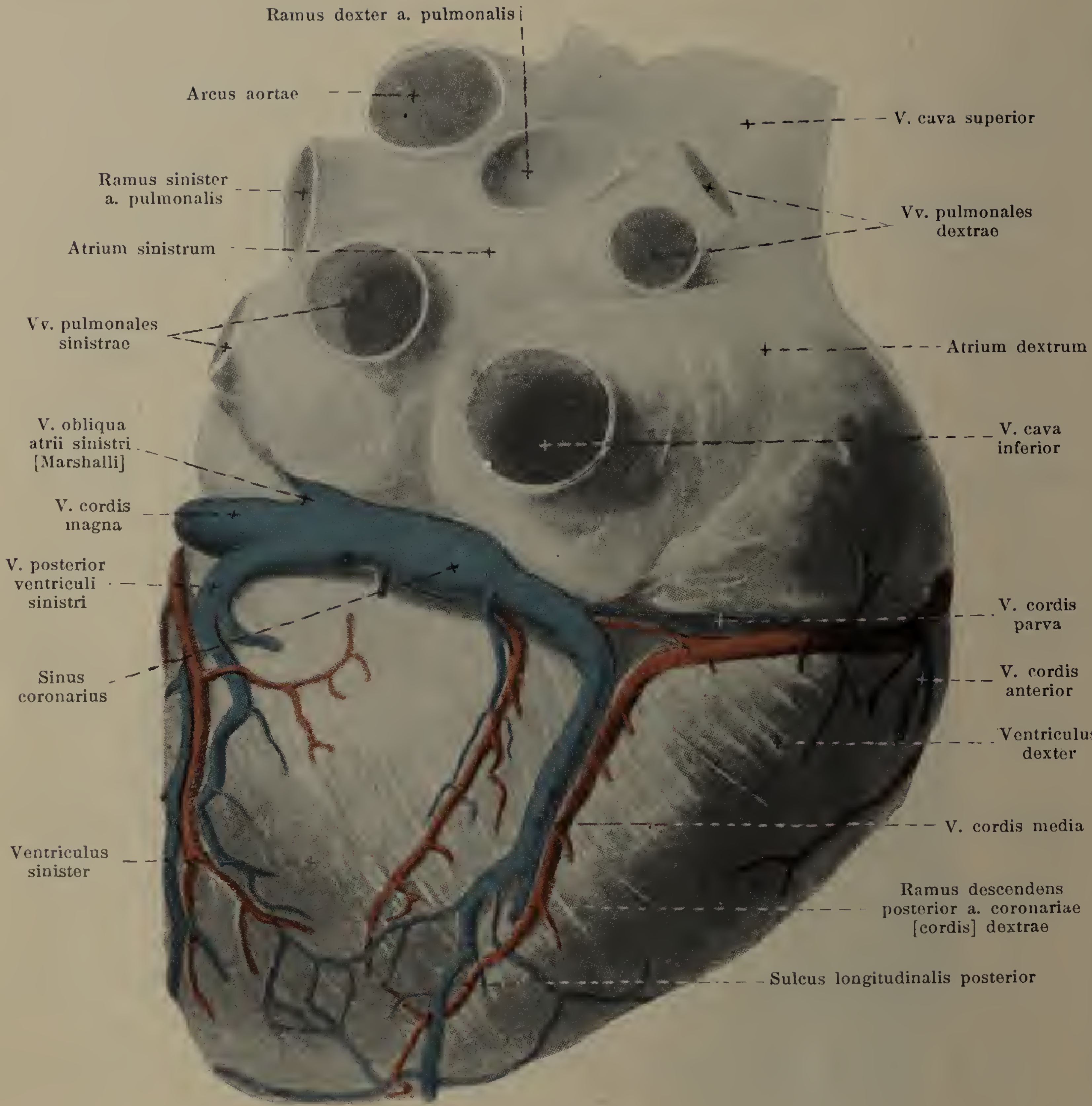

Ramus dexter a. pulmonalis
Arcus aortae
V. cava superior
Ramus sinister a. pulmonalis
Vv. pulmonales dextrae
Atrium sinistrum
Vv. pulmonales sinistrae
Atrium dextrum
V. cava inferior
Ligamentum v. cavae sinistrae
Mouth of the sinus coronarius
A. coronaria [cordis] sinistra
A. coronaria [cordis] dextra
Ramus descendens posterior
Ventriculus sinister
Ventriculus dexter
Sulcus longitudinalis posterior
Ramus descendens anterior a. coronariae [cordis] sinistrae

480. The arteries of the heart, viewed from below.

The **a. coronaria [cordis] sinistra** *(left coronary artery)* (see also Fig. 479) arises from the left sinus aorta [Valsalvae] (see Figs. 477 and 484), is usually larger than the right and divides just after its origin into two branches. The *ramus descendens anterior* extends at first behind the a. pulmonalis, then to the left from it, covered by the left auricular appendix, to the sulcus longitudinalis anterior, in which it runs as far as the incisura [apicis] cordis, usually going over upon the facies diaphragmatica; it gives off larger branches to the septum ventriculorum and the left ventricle and smaller branches to the right ventricle. The *ramus circumflexus*, hidden below the left auricular appendix, goes in the sulcus coronarius first to the left, then upon the facies diaphragmatica to the right and does not reach the sulcus longitudinalis posterior; it gives off larger branches to the left ventricle and smaller ones to the left atrium.

Both aa. coronariae vary not rarely in as much that the ramus circumflexus of the left reaches on the facies diaphragmatica as far as to its right margin (and thereby gives off the r. descendens posterior), or that the right may run as far as the left margin; in the first case the right, in the last case the ramus circumflexus of the left is shortened accordingly.

Both aa. coronariae anastomose with one another by means of innumerable minute branches, usually inside the muscle, more rarely on the outer surface just beneath the epicardium.



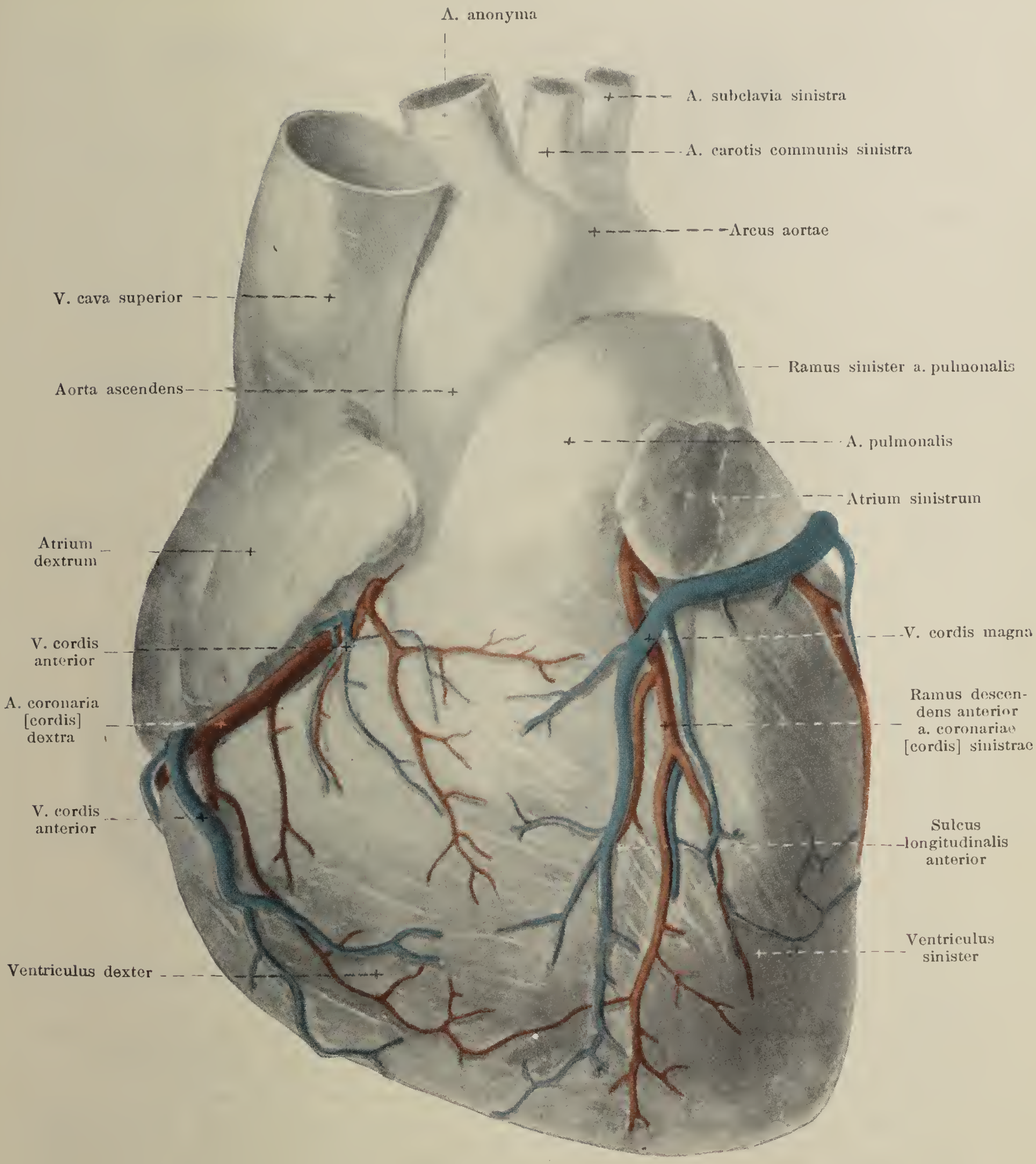
481. The veins of the heart, viewed from below.

Most of the **veins of the heart** open into the *sinus coronarius*. This lies on the facies diaphragmatica in the sulcus coronarius, extends to the left as far as the opening of the v. obliqua atrii sinistri [Marshalli] and opens at the right into the right atrium (see Fig. 473); it arises from the cross-piece of the embryonic sinus reuniens (see also p. 394) and, as such, possesses cross-striped (cardiac) muscle fibres. The vein openings into the sinus are partly closed at their mouths by valves, which, elsewhere, are absent. All the veins of the heart anastomose with one another.

The *v. cordis parva* opens from the right into the sinus; it runs in the sulcus coronarius and comes partly from the right ventricle, partly from the right atrium.

The *v. cordis media* extends in the sulcus longitudinalis posterior from the apex of the heart to the base; it receives its branches from both ventricles and from the septum ventriculorum and opens from the right into the sinus.

The *v. obliqua atrii sinistri [Marshalli]* (O. T. oblique vein of Marshall) runs downward as a small branch on the left side of the left atrium in front of the pulmonary veins and opens from the left into the sinus. It connects above with the fine, fibrous *ligamentum venae cavae sinistrae* (see Fig. 463) which runs downward from the v. anonyma sinistra in front of the left pulmonary vessels and gives rise to a low fold of the epicardium; together with this ligament the v. obliqua atrii sinistri is a remnant of the embryonic v. cava sinistra.



482. The veins of the heart, viewed from above and in front.

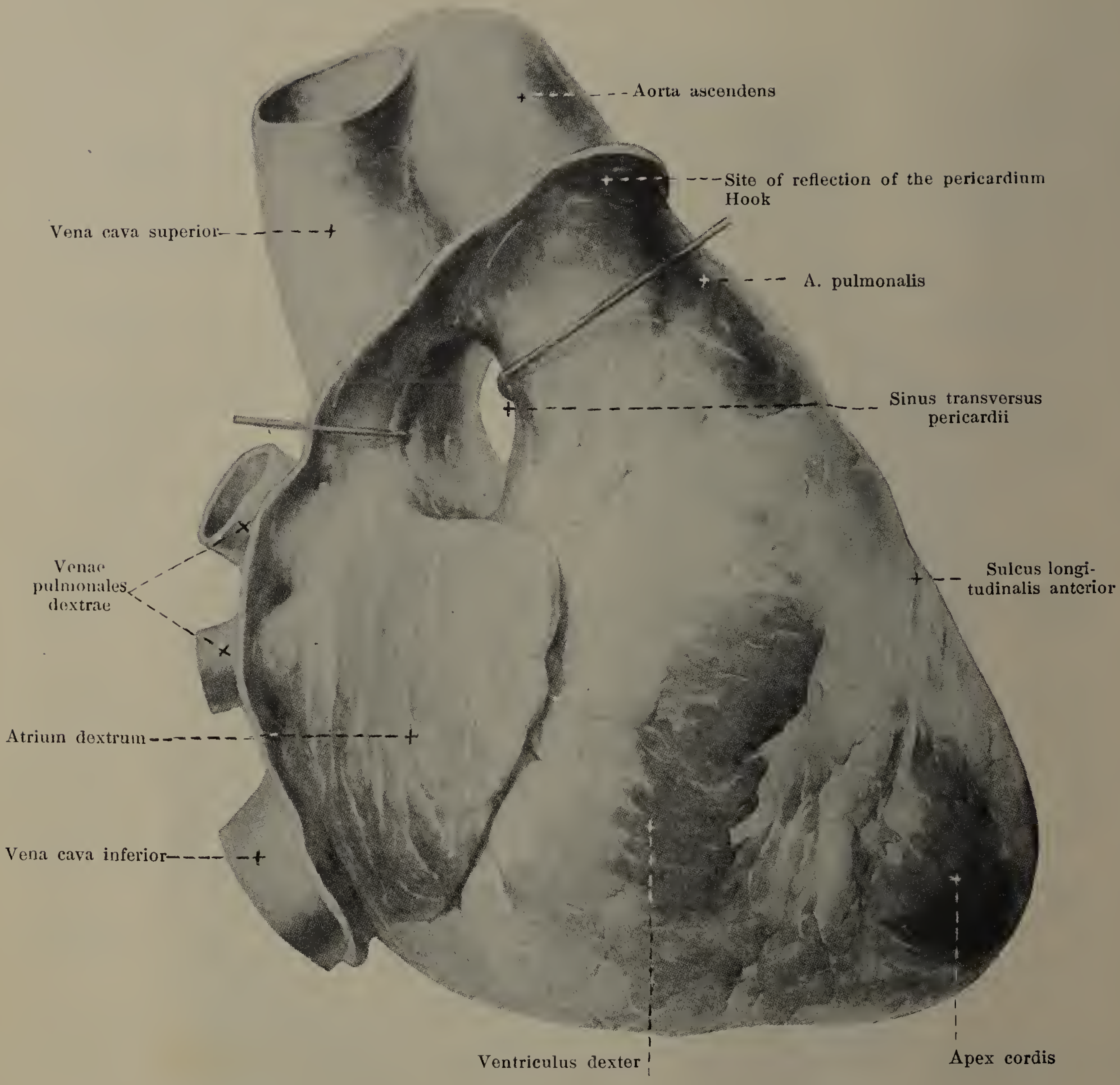
The **veins of the heart** (continued) (see also Fig. 481).

The *v. posterior ventriculi sinistri*, on the left side of the heart, receives branches from the left ventricle and opens into the v. cordis magna or to the right into the sinus coronarius.

The *v. cordis magna* arises at the apex of the heart, runs at first in the sulcus longitudinalis anterior toward the base, then in the sulcus coronarius around the left surface to the sinus coronarius; it collects its blood partly from the right, but chiefly from the left ventricle, from the septum ventriculorum and from the left fore-chamber.

The *vv. cordis anteriores*, varying in number, upon the right ventricle, open at the sulcus coronarius directly into the right atrium.

The *vv. cordis minimae* open directly into the cavities of the right and left heart by means of the *foramina venarum minimarum [Thebesii]* (see Fig. 471).

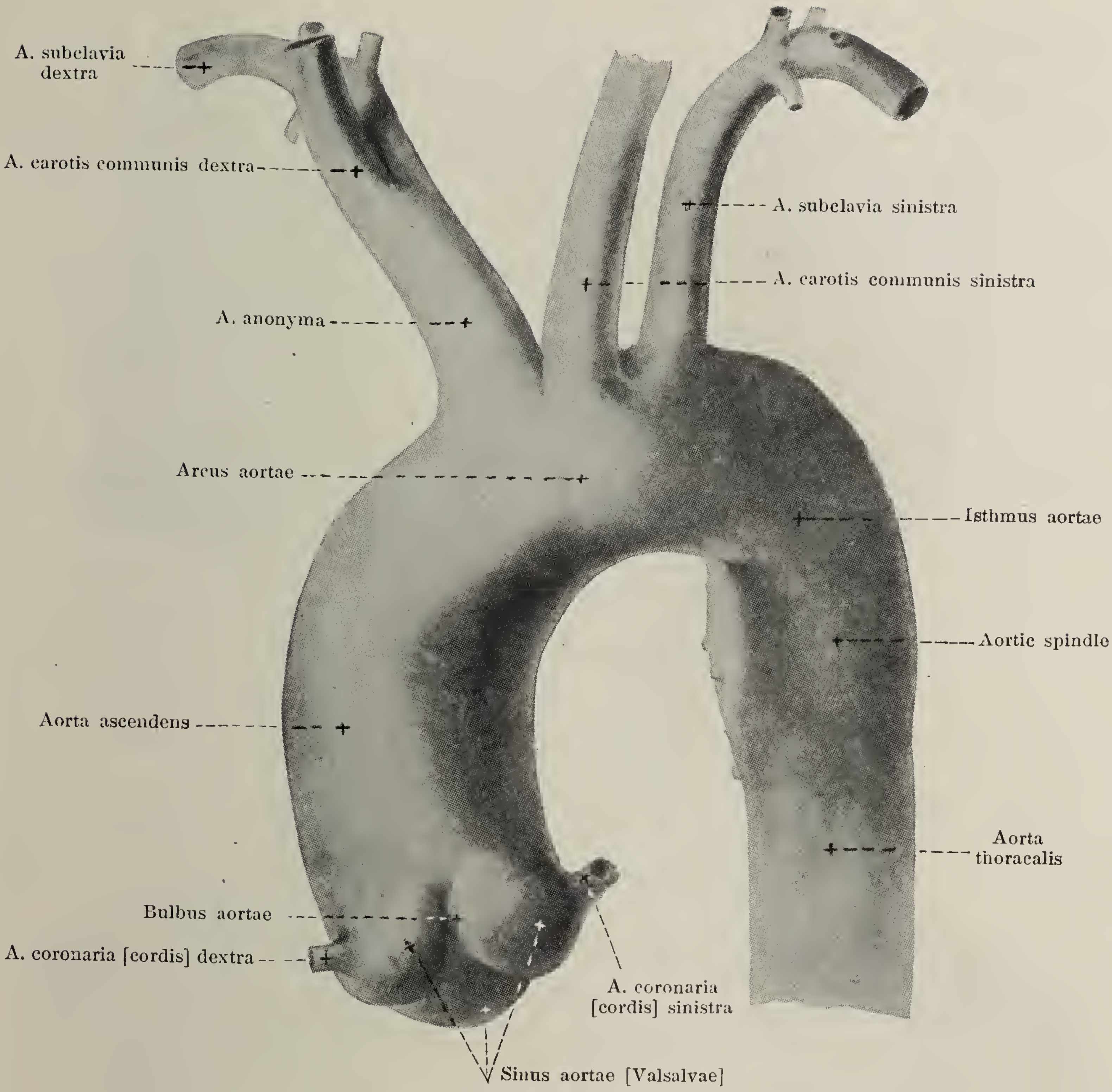


483. The heart, *viewed from the right and in front,* showing the place where the pericardium is reflected.

(The large arteries have been drawn away somewhat from the atria.)

The **pericardium** (see also Figs. 678—683) is a serous sack, closed on all sides, which presents a visceral layer, *epicardium,* firmly attached to the heart muscle, and a parietal layer. Between the two layers is a small slit-like space in which are contained several grams of a clear serous fluid, the *liquor pericardii.*

The *epicardium* (see also Figs. 462 and 463) covers completely the free surface of the ventricles of the heart and contains deposits of fat of variable size along the vessels. The atria are also covered on their free surface in large part by the epicardium, only the posterior surface of the left and a narrow, vertical strip of the right atrium remaining free from it; the v. cava superior is covered by it for a distance of one little finger's breadth; the v. cava inferior and vv. pulmonales are covered by it only at the point where they open into the heart. The a. pulmonalis and aorta ascendens are connected with one another by connective tissue, are covered in common by the epicardium and are separated from the anterior wall of the atria by a slit, the *sinus transversus pericardii,* which is closed above and below but open to the right and to the left. The epicardium is reflected into the parietal layer of the pericardium along the junction between the aorta ascendens and the arcus aortae, as well as over the bifurcation of the a. pulmonalis.



484. Aortic arch with its branches,

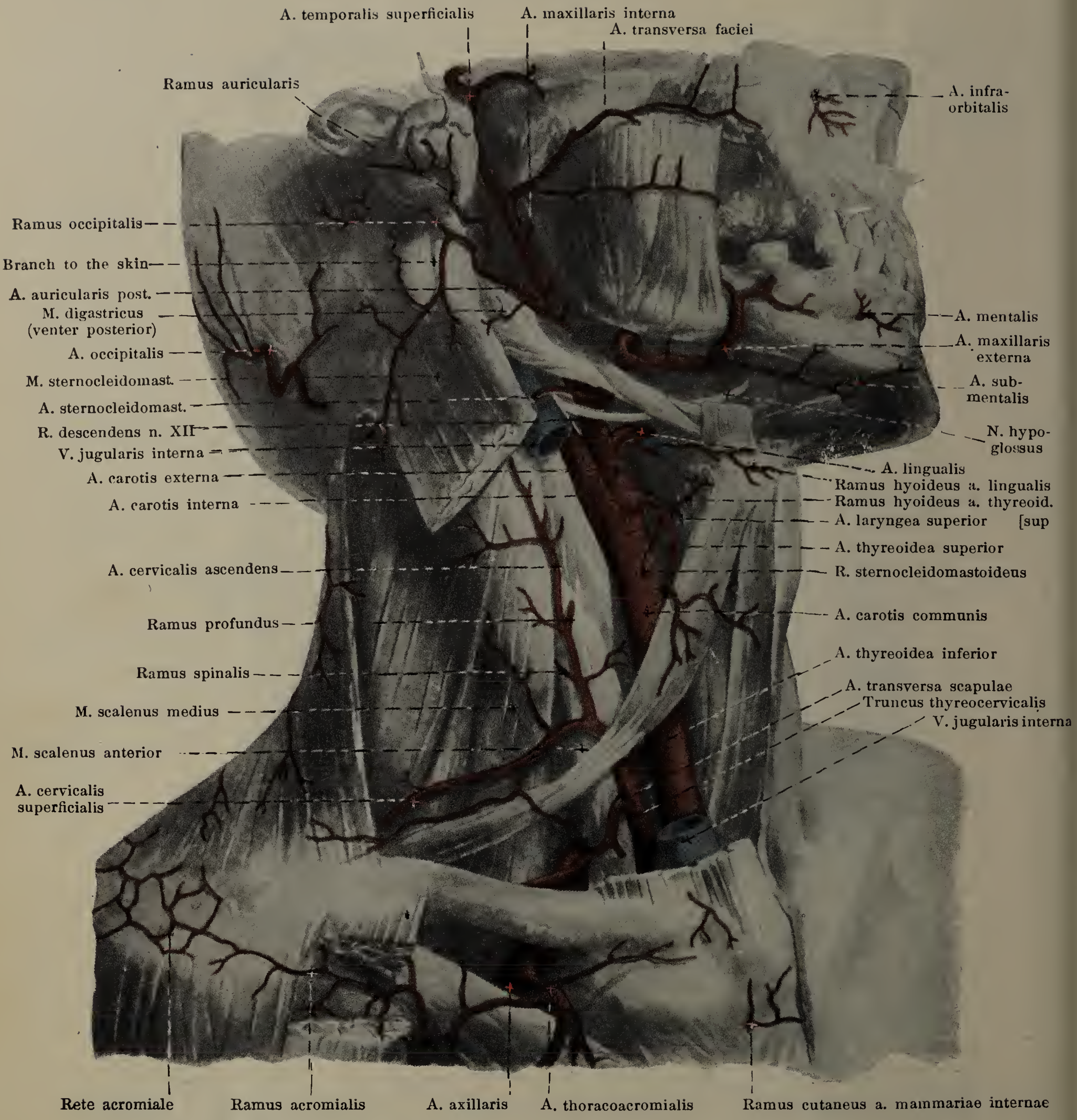
viewed from the left and in front.

(After a plaster mould.)

Pericardium (continued) (see Figs. 483, 678—683). The *parietal layer* is fused, on its lower surface, firmly with the diaphragm, on the posterior surface loosely with the oesophagus and the aorta thoracalis; to the right and left it is intimately united with the pleura pericardiaca. In front it is partly covered by the thymus and loosely connected with it; it lies in part just behind the corpus sterni and is fastened to it by several powerful, tendinous bands of fibres, the *ligamenta sternopericardiaca* (not illustrated), as well as by loose connective tissue.

The **aorta** runs, from the ostium arteriosum sinistrum, at first, upward *(aorta ascendens);* it then bends around backward *(arcus aortae)*, and goes finally downward *(aorta descendens)*, above, in front of the thoracic spine *(aorta thoracalis)*, below, in front of the lumbar spine *(aorta abdominalis).* It ends in front of the lower margin of the 4th lumbar vertebra, a little below the navel.

The beginning of the **aorta ascendens** (see also Figs. 461, 462, 478 and 479) lies behind that of the a. pulmonalis and presents a flask-like swelling *(bulbus aortae)* with three smaller bulgings *(sinus aortae [Valsalvae])*, of which each corresponds to one valvula semilunaris aortae. Thence the aorta passes upward and turns only a little to the right and forward; it lies behind the right auricular appendix of the heart and ascends in the median plane behind the corpus sterni, on the right side of the a. pulmonalis and on the left side of the v. cava superior; behind, it adjoins the left atrium and the ramus dexter a. pulmonalis. The only larger branches given off by it are the two *aa. coronariae [cordis]* (see pp. 400 and 401).



485. Superficial arteries of the neck,
viewed from the right and somewhat from in front.
(The head is bent somewhat backward; the parotid gland has been completely removed; the mm pectoralis major, sternocleidomastoideus and the muscles of the face have been partially removed.)

The **arcus aortae** ***(aortic arch)*** (see Figs. 478, 484, 607, 681 and 682) arches upward, being convex, from before backward, and at the same time somewhat to the left, crossing the point of division of the a. pulmonalis and the bronchus sinister; on the right it lies upon the trachea just above its bifurcation; its highest convexity reaches to the level of the breast-bone junction of the first rib; below it ends on the left side of the body of the 4th thoracic vertebra.

From the upper wall of the aortic arch go off: *a. anonyma, a. carotis communis sinistra* and *a. subclavia sinistra.*

At the junction of the arcus aortae with the aorta thoracalis there is frequently a constriction, the *isthmus aortae*, and, just beyond this, an oblong expansion, the *aortic spindle* (see Fig. 484). Both formations are especially well marked when the vessel is much curved.

A. anonyma (innominate artery) (see Figs. 478, 500 and 607) runs obliquely in front of the trachea from the left and below to the right and upward, covered in front by the venae anonymae; it divides behind the articulatio sternoclavicularis dextra and somewhat above it into the *a. carotis communis dextra* and the *a. subclavia dextra*.

A. carotis communis (common carotid artery) (see also Figs. 358, 486, 492, 500 537 and 540) runs (left behind the articulatio sternoclavicularis), at first on the right somewhat farther forward, on the lateral side of the trachea and oesophagus, then behind the lobe of the thyroid gland, in front of the mm. scaleni and longus colli, upward and somewhat backward and divides near the cornu superius of the cartilago thyreoidea into the *a. carotis externa* and the *a. carotis interna*. It is accompanied in front and lateralward by the v. jugularis interna, in front by the ramus descendens n. hypoglossi, behind by the n. vagus, and is partially covered by the mm. sternocleidomastoideus, sternohyoideus, sternothyreoideus and omohyoideus.

A. carotis externa (external carotid artery) (see also Figs. 489, 490 and 492) passes almost straight upward, partly covered by the venter posterior of the m. digastricus and by the m. stylohyoideus, runs along the posterior margin of the ramus mandibulae on its medial surface (surrounded generally on all sides by the glandula parotis) and divides at the collum mandibulae into its two terminal branches: *a. temporalis superficialis* and *a. maxillaris interna*. It is partly covered by the v. facialis communis and by the n. hypoglossus. Branches:

1. **A. thyreoidea superior** (superior thyroid artery) (see also Figs. 486, 492 and 500) arises from the anterior wall of the point of division, sometimes even somewhat more deeply; runs in a curve forward and downward to the upper end of the lateral lobe of the thyroid gland, covered partly by the venter superior of the m. omohyoideus. Branches:

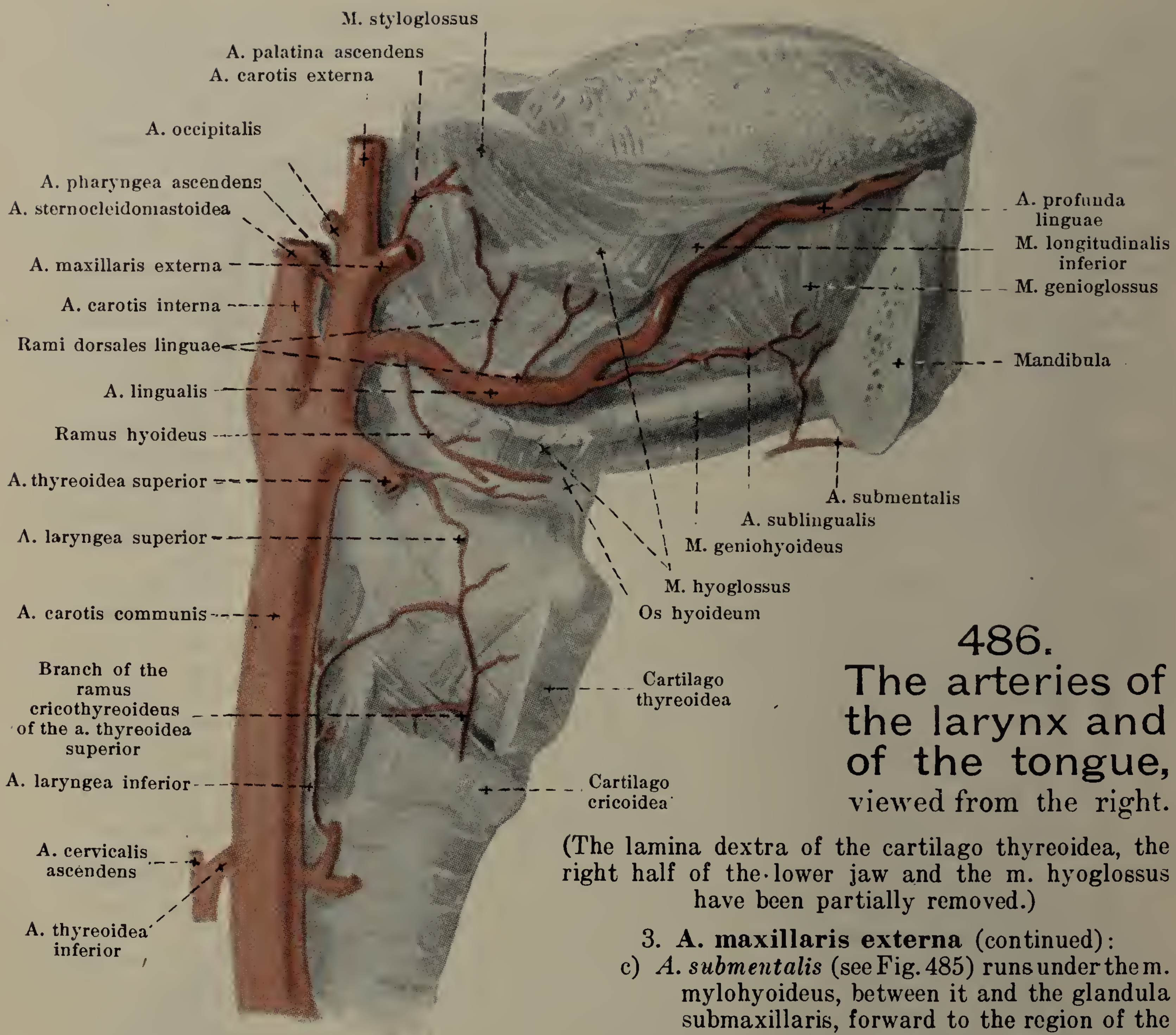
a) *Ramus hyoideus* upward to the hyoid bone.
b) *Ramus sternocleidomastoideus* lateralward and downward to the m. sternocleidomast..
c) *A. laryngea superior* perforates the membrana hyothyreoidea, being covered by the m. thyreohyoideus, and anastomoses on the lateral surface of the laryngeal muscles with the a. laryngea inferior (from the a. thyreoidea inferior) and with a branch of d).
d) *Ramus cricothyreoideus* (see Figs. 486 and 500), in front of the m. cricothyreoideus and the lig. cricothyreoideum medianward; under the cartilago thyreoidea it gives a branch to the laryngeal muscles (see c) and anastomoses with that of the other side.
e) and f) *Ramus anterior* and *ramus posterior*, to the anterior and posterior surface of the thyroid gland; both break up into numerous *rami glandulares* (to the gland).

2. **A. lingualis** (lingual artery) (see also Figs. 486 and 492) goes off, at the level of the greater cornu of the hyoid bone, from the anterior wall, extends in a curve upward upon the m. constrictor pharyngis medius, then, parallel to and above the hyoid bone, medially to the m. hyoglossus forward upon the m. longitudinalis inferior and the m. genioglossus. Branches:

a) *Ramus hyoideus* downward to the lateral surface of the hyoid bone.
b) *Rami dorsales linguae*, double or single, on the medial surface of the m. hyoglossus, upward to the region of the root of the tongue and the tonsil.
c) *A. sublingualis* arises at the anterior border of the m. hyoglossus, runs between the m. mylohoideus and the m. genioglossus below the glandula sublingualis forward, supplies the floor of the mouth and the gums of the anterior teeth; it anastomoses through the m. mylohyoideus with the a. submentalis.
d) *A. profunda linguae* (O. T. ranine artery), very tortuous, runs upward and forward between the m. longitudinalis inferior and the m. genioglossus; it anastomoses above the frenulum linguae with that of the other side.

3. **A. maxillaris externa** (external maxillary artery) (O. T. facial artery) (see also Figs. 487 and 492) arises, close above the a. lingualis (sometimes in common with it), from the anterior wall, covered by the venter posterior of the m. digastricus and by the m. stylohyoideus; it runs forward in a S-shaped curve on the medial and upper surface of the glandula submaxillaris, between it and the lower jaw, then bends around the basis mandibulae to the anterior margin of the m. masseter and passes, very tortuous, upon the mm. buccinator and caninus to the side of the nose. In the face it is covered by the platysma, mm. risorius, zygomaticus and quadratus labii superioris, separated from the latter by the v. facialis anterior. Branches:

a) *A. palatina ascendens* (O. T. ascending or anterior palatine artery) (see Figs. 486 and 492) arises near the origin (frequently from the a. carotis externa or a. pharyngea ascendens), runs upward upon the m. stylopharyngeus, then between this muscle and the m. styloglossus, then upon the m. constrictor pharyngis superior to the medial surface of the m. tensor veli palatini; it supplies the soft palate and the pharynx.
b) *Ramus tonsillaris* (see Fig. 492), frequently a branch of a), runs upon the m. constrictor pharyngis superior to the tonsilla palatina and to the soft palate.



486.

The arteries of the larynx and of the tongue, viewed from the right.

(The lamina dextra of the cartilago thyreoidea, the right half of the lower jaw and the m. hyoglossus have been partially removed.)

3. **A. maxillaris externa** (continued):

c) *A. submentalis* (see Fig. 485) runs under the m. mylohyoideus, between it and the glandula submaxillaris, forward to the region of the chin; it anastomoses with the a. sublingualis.

d) *Rami glandulares*, arising partly from c), to the glandula submaxillaris.

e) *A. labialis inferior* (O. T. inferior coronary artery) (see Fig. 487) arises below the angle of the mouth, runs medianward in the lower lip in the m. orbicularis oris, close to the mucous membrane, and forms a broad anastomosis with that of the other side.

f) *A. labialis superior* (O. T. superior coronary artery) (see Fig. 487) arises at the angle of the mouth, runs in the upper lip like e) in the lower; branches to the nasal septum.

g) *A. angularis* (see Fig. 487), the terminal branch, ascends almost vertically along the lateral margin of the nose and anastomoses with the a. dorsalis nasi (from the a. ophthalmica).

4. **A. temporalis superficialis** (superficial temporal artery) (see Figs. 485, 487—489) ascends behind the proc. condyloideus mandibulae, in front of the tragus, over the root of the zygoma; it is covered at first by the glandula parotis, and then, very tortuous, lies upon the fascia temporalis and galea aponeurotica; it divides above the ear into its two terminal branches, *ramus frontalis* and *ramus parietalis*. Branches:

a) *Rami parotidei*, in part also directly from the a. carotis externa, to the parotid gland.

b) *A. transversa faciei* (O. T. transverse facial artery), runs forward to the cheek directly upon the m. masseter, just below the zygoma, covered behind by the parotid gland.

c) *Rami auriculares anteriores*, 3—4, to the auricle and to the external auditory canal.

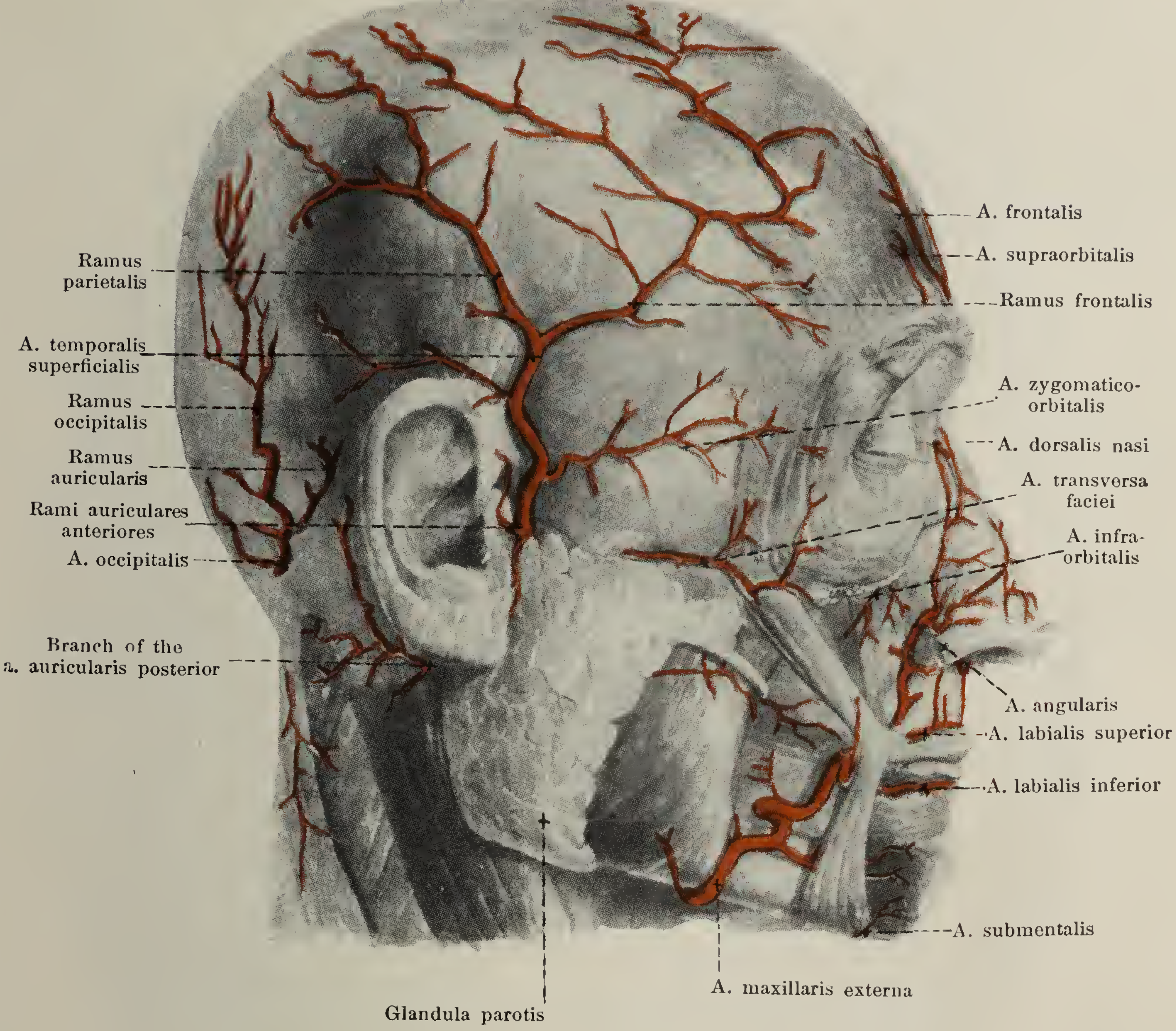
d) *A. temporalis media* (medial temporal artery) (see Fig. 489) perforates the fascia temporalis just above the root of the zygoma, runs upward in the sulcus a. temporalis mediae of the temporal bone and is distributed in the m. temporalis.

e) *A. zygomaticoorbitalis*, above the zygoma, to the upper margin of the orbit.

f) *Ramus frontalis* (O. T. anterior terminal branch), is tortuous and extends first forward and upward, then backward upon the m. epicranius.

g) *Ramus parietalis* (O. T. posterior terminal branch), tortuous, backward and upward.

f) and g) form a rich anastomotic network with one another, with the aa. frontales and occipitales.



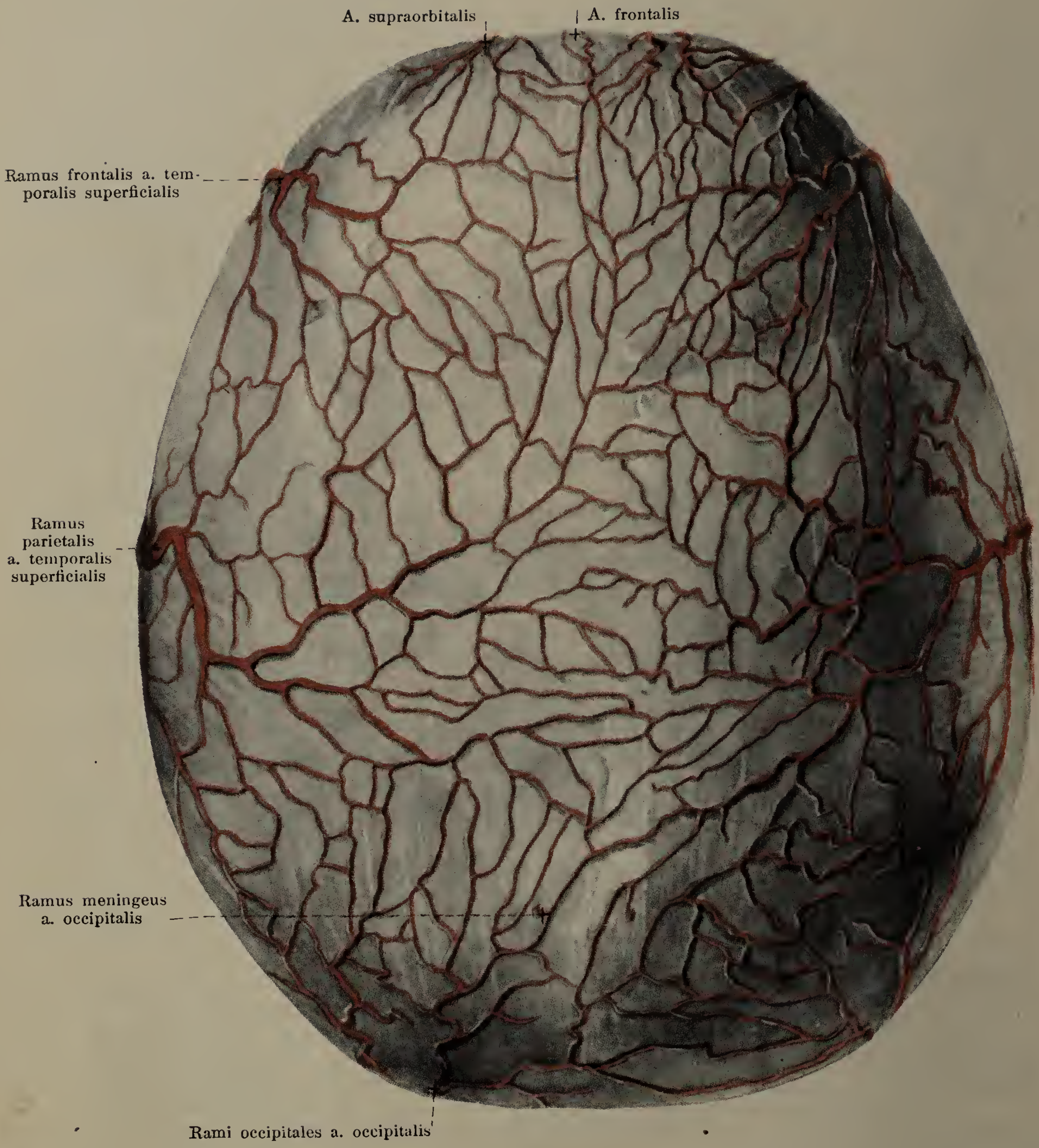
487. Superficial arteries of the face, viewed from the right.
(The platysma, m. risorius and m. quadratus labii superioris have been removed.)

5. **A. sternocleidomastoidea** (see Fig. 485) arises, at the same level as the a. maxillaris externa (often from 6.), from the outer wall and goes in a curve, in front of the n. hypoglossus and the v. jugularis interna, lateral- and downward to the m. sternocleidomastoideus.

6. **A. occipitalis** (see Fig. 489), somewhat above the previous artery, from the posterior wall, runs at first upward upon the v. jugularis interna, covered by the venter posterior of the m. digastricus; then it goes backward in the sulcus a. occipitalis between the m. rectus capitis lateralis and the venter posterior m. digastrici, then between the mm. splenius capitis and semispinalis capitis; finally it bends upward and arrives between the insertions of the mm. trapezius and sternocleidomastoideus at the linea nuchae superior upon the m. epicranius. Branches:

- a) *Rami musculares* to the m. sternocleidomast. and neighboring muscles; among these
- aa) *Ramus descendens,* downward between the mm. splenius capitis and semispinalis capitis.
- b) *Ramus mastoideus* through the foramen mastoideum to the dura mater (see also Fig. 490).
- c) *Ramus auricularis* obliquely upward and forward toward the ear.
- d) *Rami occipitales,* very tortuous, upward; those of the two sides anastomose with one another and with the aa. temporales superficiales. A small branch, the *ramus meningeus,* goes through the foramen parietale to the dura mater.

7. **A. auricularis posterior** (posterior auricular artery) (see Figs. 485 and 489), above the preceding from the posterior wall, runs, covered by the glandula parotis, on the upper margin of the venter post. m. digastrici, upward and in front of the proc. mastoideus behind the ear. Branches:


A. supraorbitalis
A. frontalis
Ramus frontalis a. temporalis superficialis
Ramus parietalis a. temporalis superficialis
Ramus meningeus a. occipitalis
Rami occipitales a. occipitalis

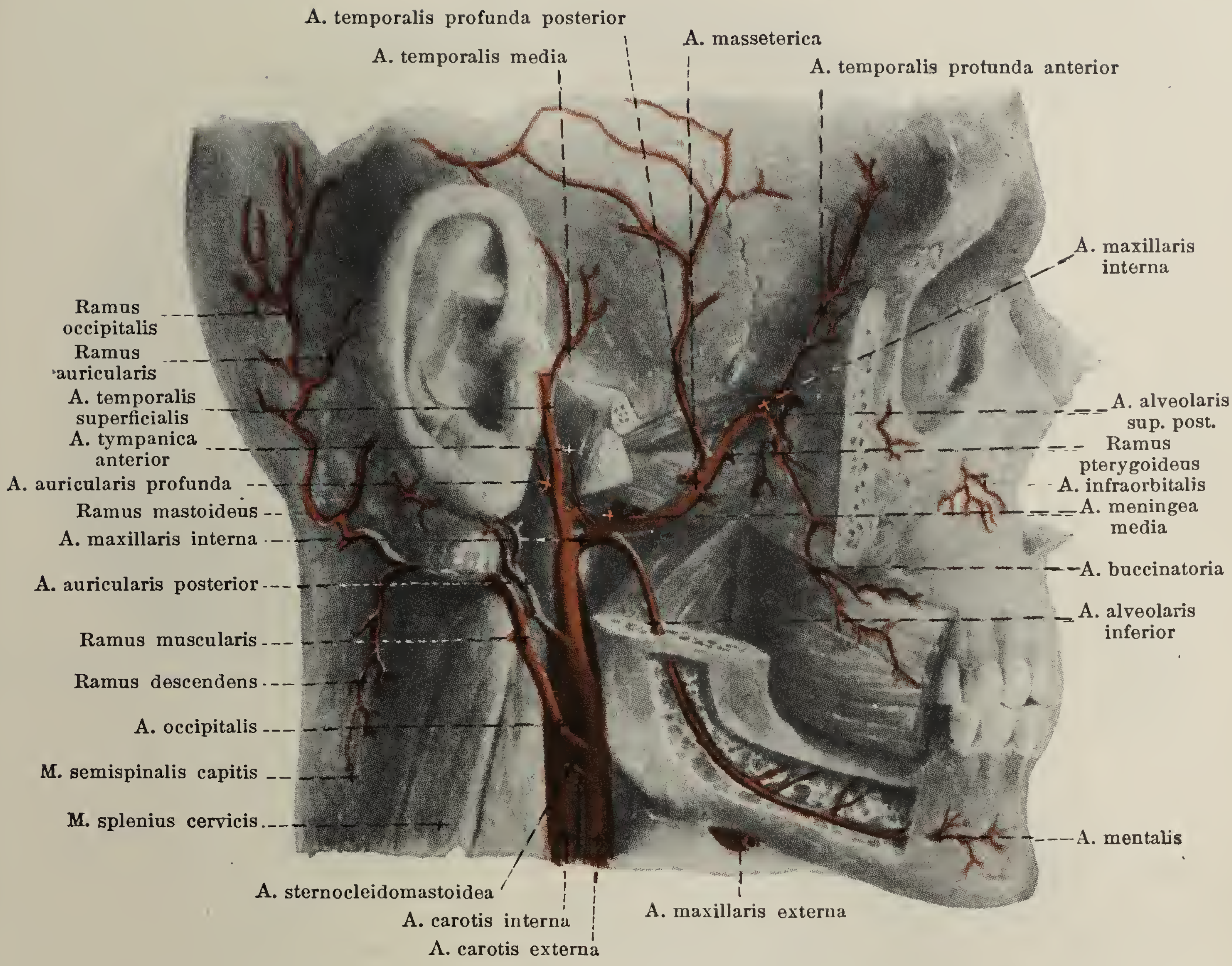
488. Arteries of the roof of the skull, viewed from above.

7. **A. auricularis posterior** (continued):

a) *A. stylomastoidea* (see Figs. 492 and 493) goes through the foramen stylomastoideum into the canalis facialis, there gives off branches backward to the cellulae mastoideae *(rami mastoidei)*, forward to the m. stapedius *(ramus stapedius)* and through the canaliculus chordae tympani into the middle ear *(a. tympanica posterior)*; it anastomoses with the ramus petrosus superficialis (from the a. meningea media) (see p. 412).

b) *Ramus auricularis* (O. T. anterior terminal branch) to the medial surface of the external ear, and partly, perforating it, to the lateral surface of the same.

c) *Ramus occipitalis* (O. T. posterior terminal branch) behind the ear, upward; it anastomoses with the a. occipitalis and the a. temporalis superficialis.



489. Deep arteries of the face, viewed from the right.

(The parotid gland has been entirely removed, the zygoma, the ramus of the lower jaw and the muscles of the lower jaw have been partially removed [see Fig. 345]; the canalis mandibulae has been chiselled open in a part of its course.)

8. **A. maxillaris interna** (internal maxillary artery) (see also Figs. 490—492) runs medially forward from the collum mandibulae (1st portion), then, tortuous, forward, medianward and upward, usually on the lateral surface of the m. pterygoideus externus between it and the m. temporalis (2nd portion) to the fossa pterygopalatina, in which or before which (3rd portion) it divides into its terminal branches. Nearly in half the cases it lies on the medial surface of the m. pterygoideus externus and arrives between the two heads of this muscle into the fossa pterygopalatina. Branches:

1st portion (four branches):

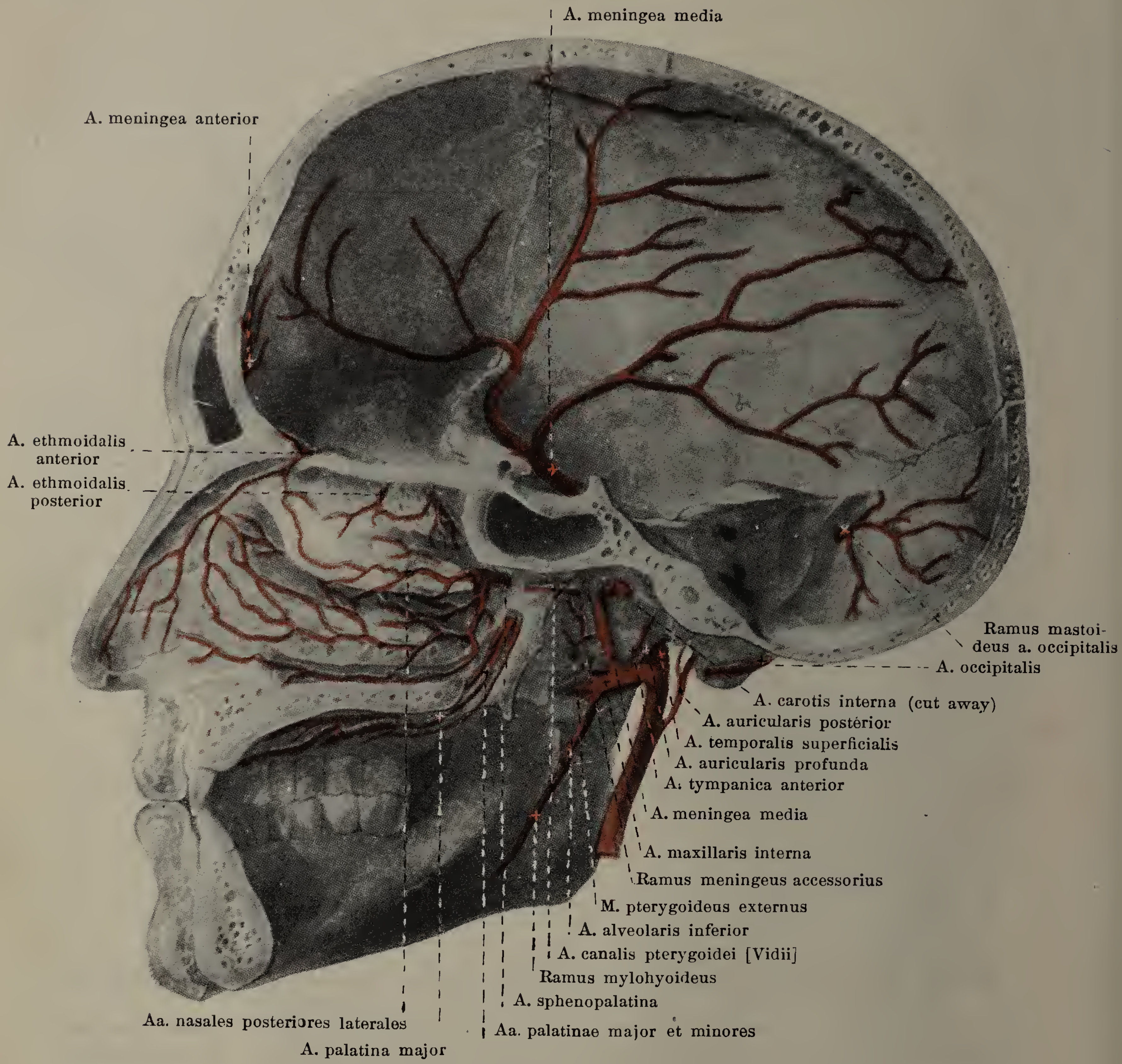
a) *A. auricularis profunda* backward to the joint of the jaw, auditory canal and tympanic membrane.

b) *A. tympanica anterior* upward through the fissura petrotympanica [Glaseri] into the middle ear.

c) *A. alveolaris inferior* (O. T. mandibular or inferior dental artery) runs downward and forward between the ramus mandibulae and the m. pterygoideus internus to the foramen mandibulare; it passes through the canalis mandibulae, giving off branches to the roots of the teeth, gums and bone. Branches:

ca) *Ramus mylohyoideus* goes off before the entrance of the artery into the canalis mandibulae and runs, in the sulcus mylohyoideus, forward and downward.

cb) *A. mentalis* leaves the canal through the foramen mentale and goes to the chin.



490. Arteries of the skull and of the nasal cavity,
right half, viewed from within.
(The canalis pterygoideus and the canales palatini have been partly chiselled open.)

8. **A. maxillaris interna** (see also Figs. 489, 491 and 492) (continued):

d) *A. meningea media* (middle meningeal artery) bends under the m. pterygoideus externus upon its medial surface, passes upward to the foramen spinosum and is distributed inside the skull, at first imbedded in the sulci arteriosi of the sphenoid bone and the parietal bone, to the dura mater of the frontal, temporal and parietal region. Through the fissura orbitalis superior it anastomoses with the a. lacrimalis. Branches:

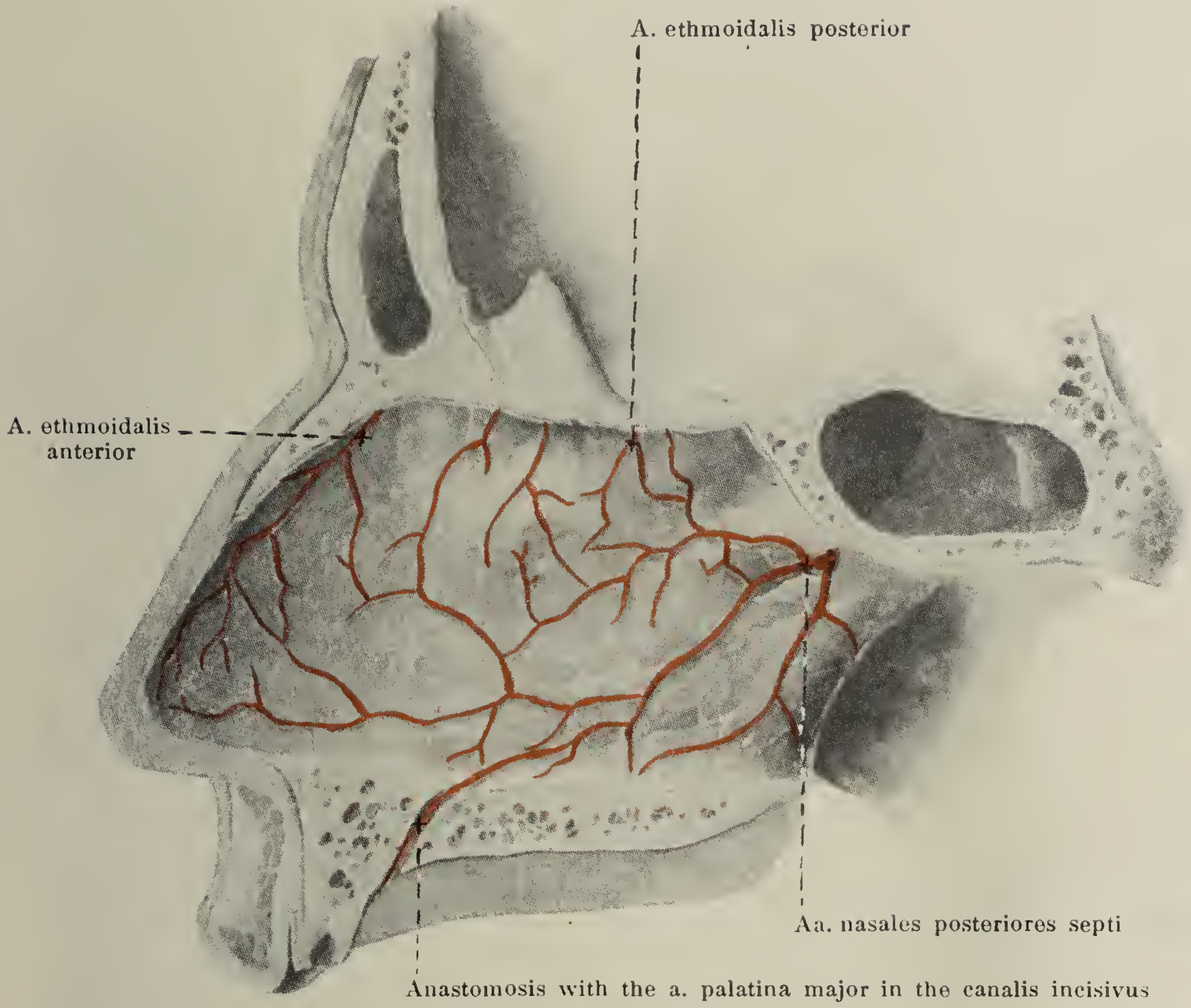
da) *Ramus meningeus accessorius* goes off outside the skull, often directly from the a. maxillaris interna, to the mm. pterygoidei, tuba auditiva and its neighborhood.

db) *Ramus petrosus superficialis* (O. T. petrosal branch) (see Fig. 493) arises just above the foramen spinosum, runs lateralward and backward to the hiatus canalis facialis and anastomoses there with the a. stylomastoidea (from the a. auricularis posterior).

dc) *A. tympanica superior* (see Fig. 493) arises like the preceding branch, goes through the apertura superior canaliculi tympanici and through the canalicus tympanicus into the middle ear and upon the promontorium.

2nd portion (four [muscular] branches):

e) *A. masseterica* goes lateralward through the incisura mandibulae to the m. masseter.


A. ethmoidalis posterior
A. ethmoidalis anterior
Aa. nasales posteriores septi
Anastomosis with the a. palatina major in the canalis incisivus

491. Arteries of the nasal septum, viewed from the left.

8. **A. maxillaris interna** (see also Figs. 489, 490 and 492) (continued):

f) *Aa. temporales profundae posterior et anterior* (posterior and anterior deep temporal arteries) upward in the m. temporalis, the posterior close upon the squama temporalis, the anterior upon the ala magna ossis sphenoidalis.

g) *Rami pterygoidei*, varying in number, often from f) or h), to the mm. pterygoidei.

h) *A. buccinatoria* (O. T. buccal branch), downward and forward to the m. buccinator, for muscles of the face, mucous membrane of the mouth and gums of the upper jaw.

3rd portion (four branches):

i) *A. alveolaris superior posterior* (posterior dental or alveolar branch) arises near the fossa pterygopalatina, passes forward and downward through the foramina alveolaria maxillae in the canales alveolares to the sinus maxillaris, upper molar teeth and their gums.

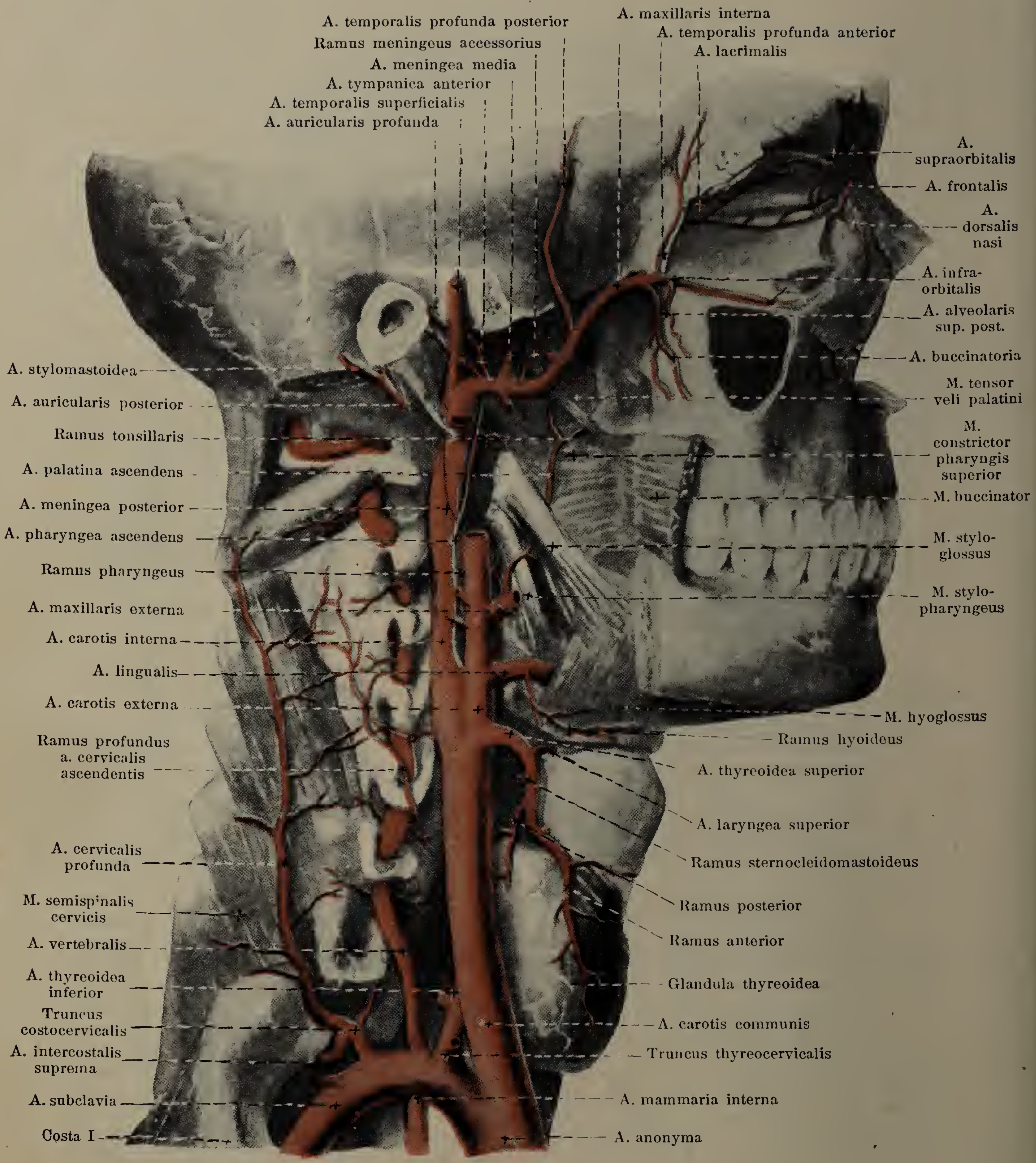
k) *A. infraorbitalis*, forward through the fissura orbitalis inf. to the sulcus and canalis infraorbitalis, gives off branches to the orbital contents, and also the *aa. alveolares superiores anteriores* (O. T. anterior dental branch) in the canales alveolares to the anterior teeth and their gums; terminal branches through the foramen infraorbitale to the face.

l) *A. palatina descendens* (O. T. posterior or descending palatine branch) passes downward to the canalis pterygopalatinus. Above it gives off the *a. canalis pterygoidei [Vidii]* (O. T. Vidian artery) which goes through the canalis pterygoideus backward to the roof of the pharynx. Below it divides into the *aa. palatinae minores et major*, which run through the canales palatini and emerge from the foramina palatina minora et majus; the minor branches go to the soft palate and its surroundings, the major branch goes to the inferior surface of the hard palate as far forward as the gums.

m) *A. sphenopalatina* (O. T. sphenopalatine or nasopalatine artery), through the foramen sphenopalatinum into the nose; it supplies the lateral wall of the nose and the pharynx by means of the *aa. nasales posteriores laterales.* runs at the inferior surface of the body of the sphenoid to the nasal septum and breaks up into the *aa. nasales posteriores septi* which anastomose in the canalis incisivus with the a. palatina major.

9. **A. pharyngea ascendens** (ascending pharyngeal artery) (see Figs. 492 and 493) from the posterior surface, near the a. lingualis, ascends, at first between the a. carotis externa and interna, then in front of the latter between it and the lateral wall of the pharynx, medial from the mm. styloglossus and stylopharyngeus, as far as the base of the skull. Branches:

a) *Rami pharyngei*, 2—3, partly descending, partly ascending, to the pharynx and palate.

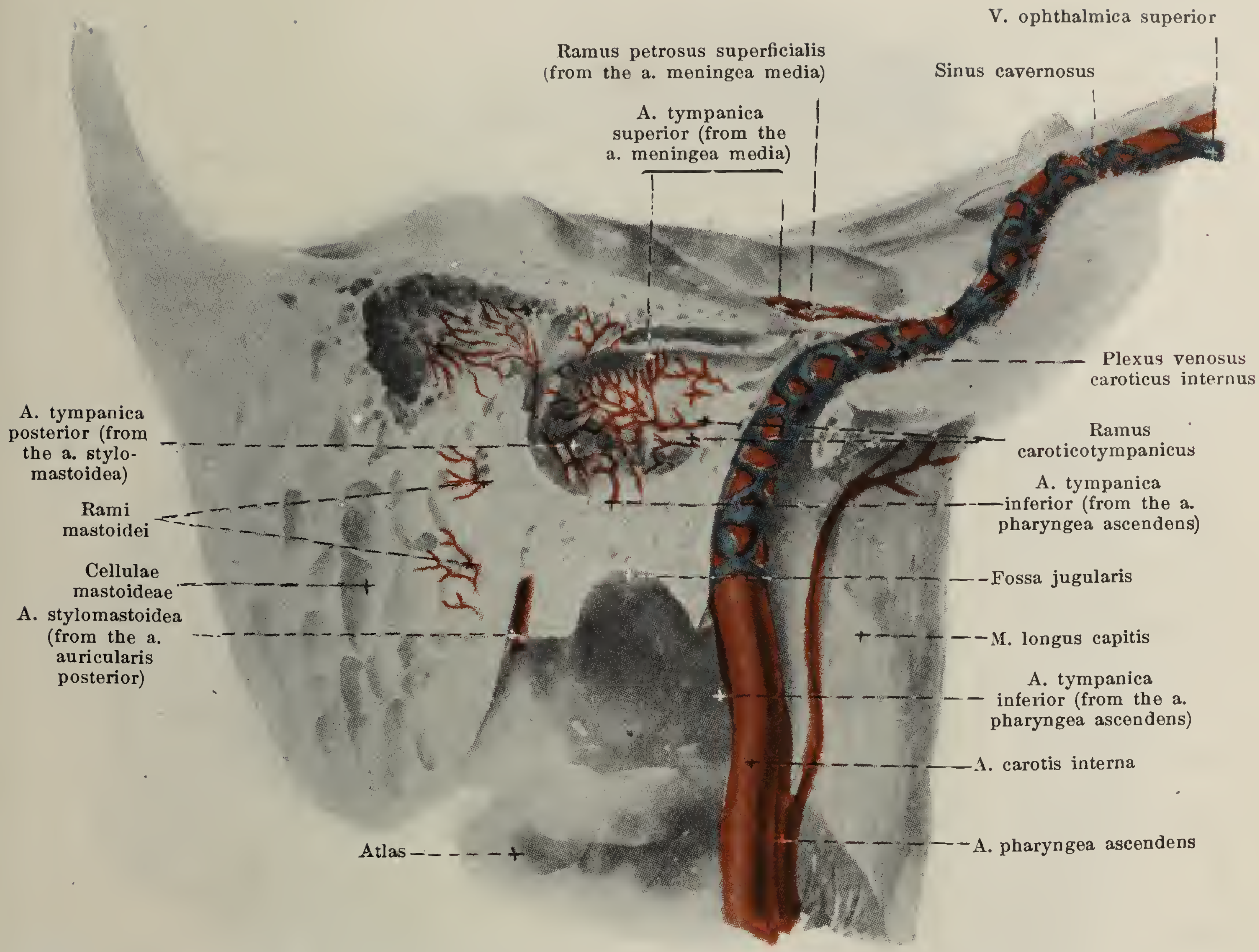


492. Deep arteries of the neck, viewed from the right.
(The muscles of the neck and face have been in large part removed; the bones of the face have been partially removed.)

9. **A. pharyngea ascendens** (continued).

b) *A. meningea posterior* ascends upon the lateral surface of the a. carotis interna and goes through the foramen jugulare to the dura mater (see Fig. 498).

c) *A. tympanica inferior* (see Fig. 493) passes through the fossula petrosa and the canaliculus tympanicus into the middle ear and upon the promontorium.

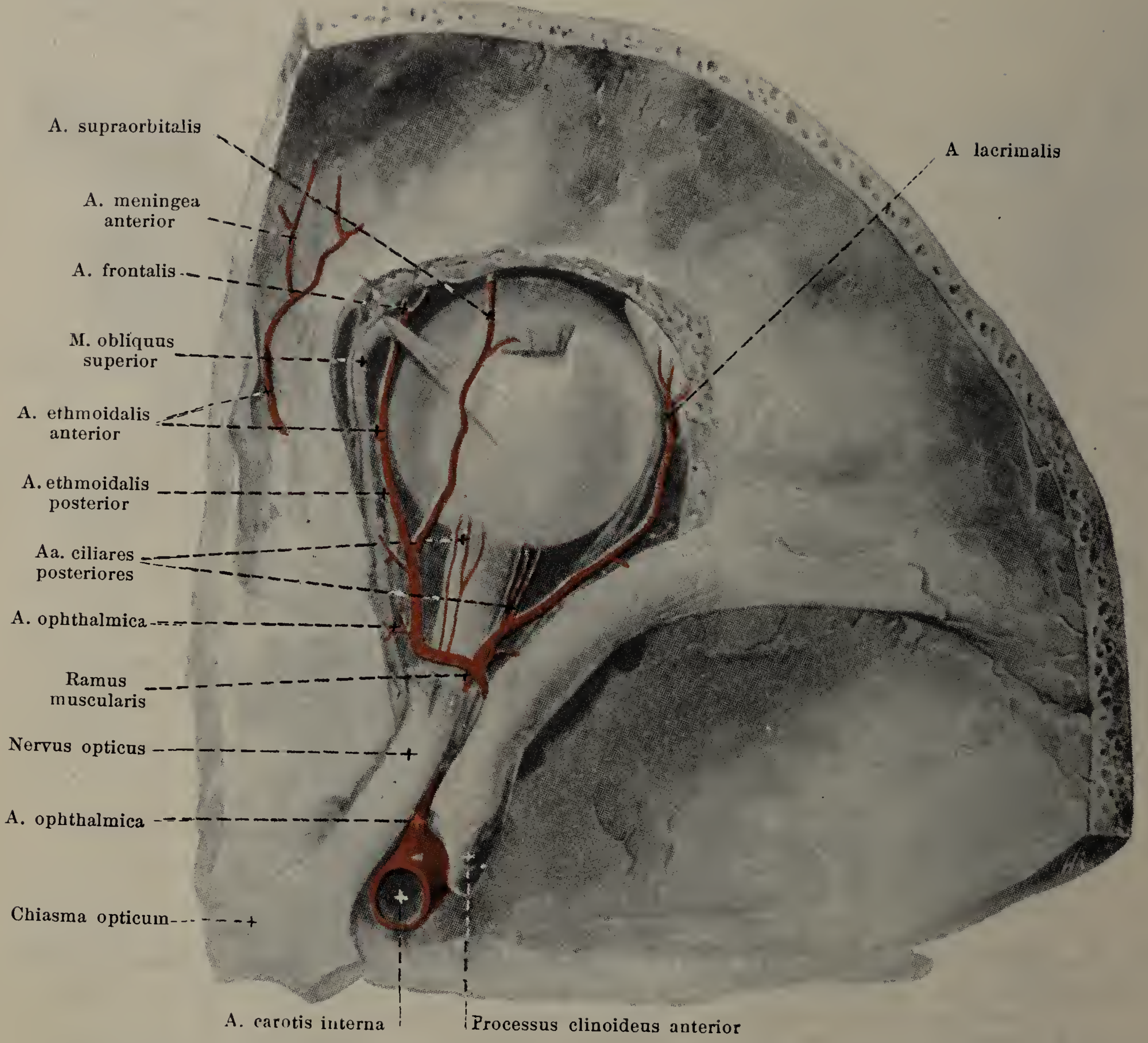

V. ophthalmica superior
Ramus petrosus superficialis (from the a. meningea media)
Sinus cavernosus
A. tympanica superior (from the a. meningea media)
Plexus venosus caroticus internus
A. tympanica posterior (from the a. stylomastoidea)
Ramus caroticotympanicus
A. tympanica inferior (from the a. pharyngea ascendens)
Rami mastoidei
Cellulae mastoideae
Fossa jugularis
A. stylomastoidea (from the a. auricularis posterior)
M. longus capitis
A. tympanica inferior (from the a. pharyngea ascendens)
A. carotis interna
Atlas
A. pharyngea ascendens

493. A. carotis interna and the middle ear, viewed from the right.
(The temporal bone has been cut open and drawn as in Fig. 13; the plexus venosus caroticus internus has been introduced after N. Rüdinger. Magnification: 3 : 2.)

A. carotis interna (internal carotid artery) (see also Figs. 485, 492, 494, 499 and 537), curved slightly like the letter S, runs in front of the mm. longus colli and longus capitis and in front of the tubercula anteriora of the procc. transversi of the 4th—2nd cervical vertebra to the base of the skull, bounded medianward by the lateral wall of the pharynx; lateralward and behind it adjoins the v. jugularis interna, in front and lateralward below the a. carotis externa, above the glandula parotis and the mm. styloglossus and stylopharyngeus; the latter muscles separate it from the a. carotis externa. It then enters the canalis caroticus, and passes through it going first upward, then horizontally medianward and forward, runs through the foramen lacerum in a groove of the fibrocartilago basalis, turns upward and goes, slightly curved, in the sulcus caroticus of the body of the sphenoid bone to a position below the processus clinoideus anterior; there it bends sharply backward and upward, medial from the proc. clinoideus anterior and behind the foramen opticum, perforates the dura mater and breaks up into its terminal branches lateral from the chiasma opticum, below the substantia perforata anterior, *a. cerebri anterior* and *a. cerebri media.* Inside the canalis caroticus it is surrounded by the plexus venosus caroticus internus, in the sulcus caroticus by the sinus cavernosus (see also Fig. 533). In the neck it gives off no branches, in the canalis caroticus the *ramus caroticotympanicus*, in the sinus cavernosus small branches to the surrounding parts and during its course behind the foramen opticum, from the convexity of its last curve, the *a. ophthalmica.*

1. **Ramus caroticotympanicus** (O. T. tympanic branch), a fine branch which passes through one of the canaliculi caroticotympanici to the mucous membrane of the middle ear.

2. **A. ophthalmica** (see Figs. 494, 915, 916, 919—921 and 924), at the lateral inferior surface of the n. opticus, goes through the foramen opticum into the orbit, then bends somewhat upward and passes transversely over the n. opticus, between it and the m. rectus superior, to the junction of the medial with the upper wall of the orbit; there it passes, below the m. obliquus superior, forward and divides between the trochlea and the ligamentum palpebrale mediale into its terminal branches: *aa. palpebrales mediales, dorsalis nasi* and *frontalis.* Branches:



494. Arteries of the right orbit, viewed from above.
Magnification: 10 : 7.
(The bony roof and the contents of the orbit have been partially removed.)

2. **A. ophthalmica** (continued):

a) *A. centralis retinae* (central artery of the retina) (see Fig. 919 and p. 804) generally arises in common with c), perforates the medial inferior surface of the sheath of the optic nerve and passes in the axis of the same to the retina.

b) *A. lacrimalis* (lachrymal artery) runs forward over the m. rectus lateralis at the lateral wall of the orbit; it sends several aa. ciliares posteriores and small branches into the foramen zygomaticoorbitale, perforates the lachrymal gland, supplies it and ends at the lateral angle of the eye in *aa. palpebrales laterales* (one for each eyelid, see p. 417) which send fine branches, *aa. conjunctivales posteriores,* to the conjunctiva. The a. lacrimalis anastomoses with the a. meningea media through the fissura orbitalis superior.

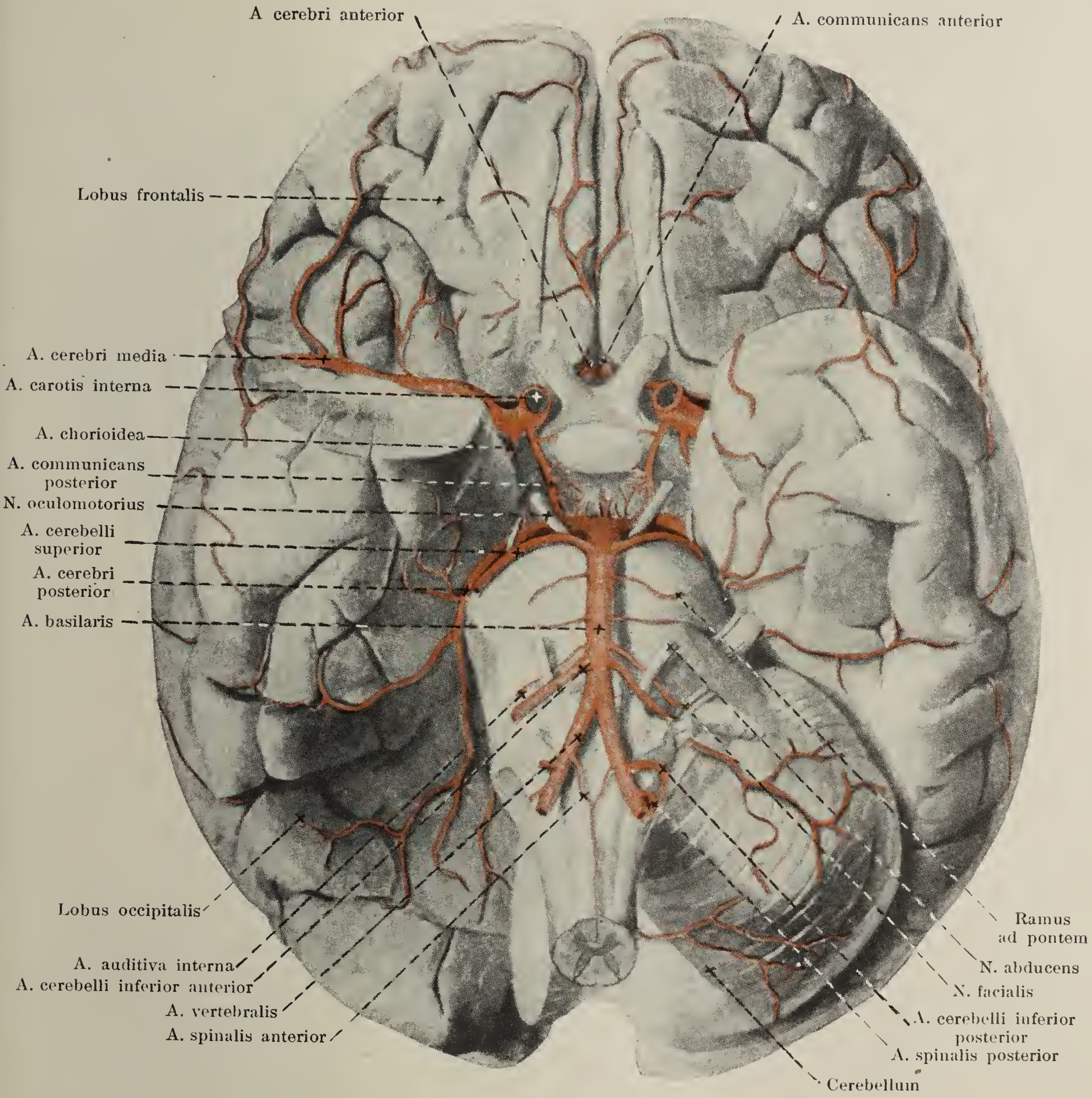
c) *Aa. ciliares posteriores breves et longae* (short and long posterior ciliary arteries), 4—6, partly from neighboring branches go, manifoldly divided, to the posterior section of the bulbus (see pp. 801 and 802).

d) *Rami musculares*, partly from neighboring branches, several in number, among them frequently one large, lateral, superior and one medial, inferior to the eye muscles.

e) *Aa. ciliares anteriores* (see p. 802) arise usually from the anterior ends of the rami musculares, run forward in the tendons of the straight right eyemuscles (see p. 802).

f) *A. supraorbitalis* (see also Figs. 487, 488 and 492) passes just below the roof of the orbit to the incisura supraorbitalis and through this to the forehead.

g) *A. ethmoidalis posterior* (see also Figs 490 and 491) through the foramen ethmoidale post. to the posterior ethmoidal cells and to the posterior superior part of the nasal cavity.



495. Arteries of the base of the brain.

(The pole of the right temporal lobe and the right side of the cerebellum have been cut away.)

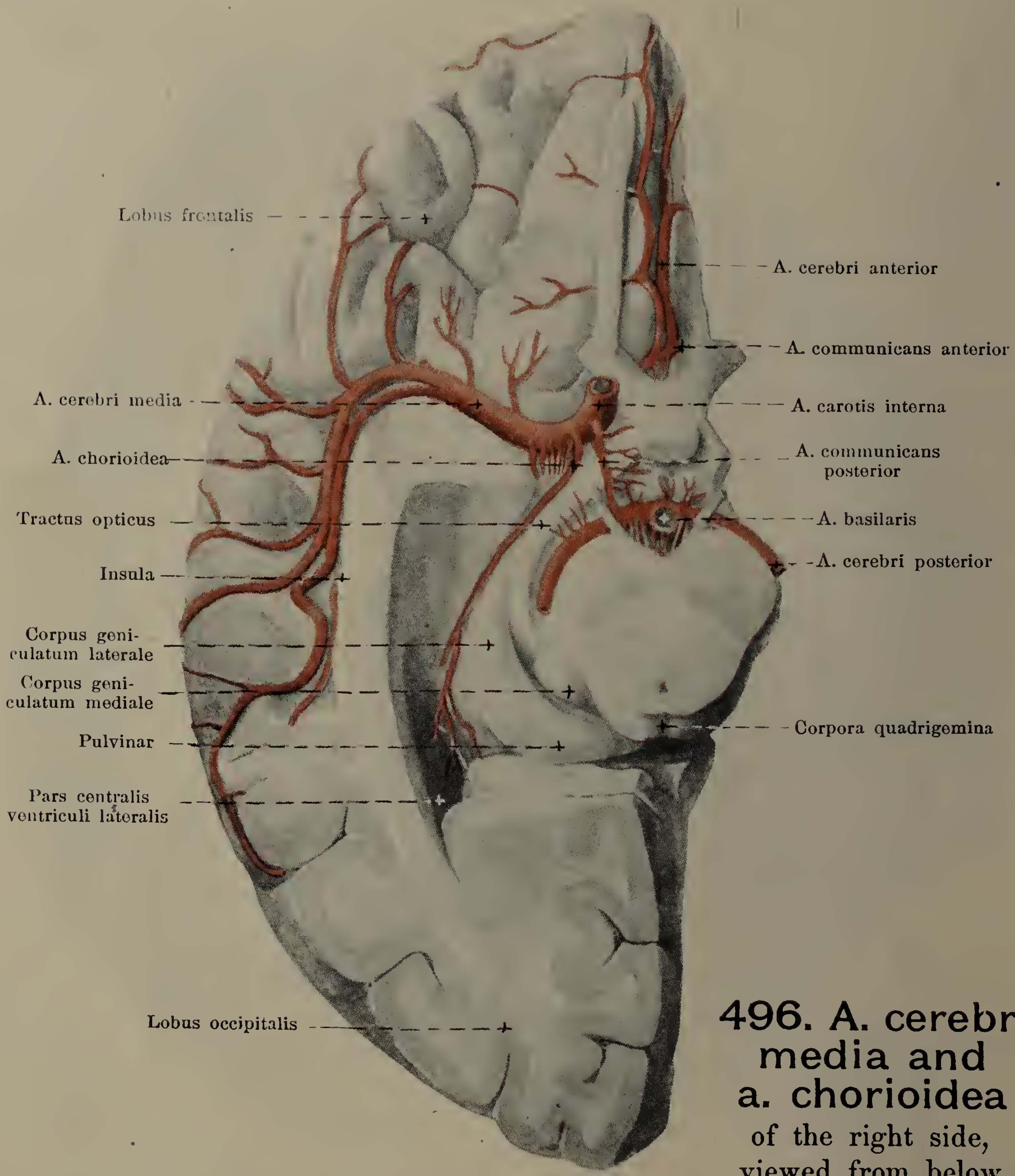
2. **A. ophthalmica** (continued):

h) *A. ethmoidalis anterior* (see Figs. 490, 491 and 494) passes through the foramen ethmoidale anterius upon the lamina cribrosa, there gives off the *a. meningea anterior* upward to the dura mater, then perforates the lamina cribrosa and supplies the anterior part of the wall of the nasal cavity *(aa. nasales anteriores).*

i) *Aa. palpebrales mediales* (not illustrated), one in each eyelid lateralward; they form by anastomosis of each medial artery with one a. palpebralis lateralis (from the a. lacrimalis) the *arcus tarseus superior* and *inferior*, situated near the free margin of the eyelid, in front of the tarsus. They give off fine branches to the conjunctiva *(aa. conjunctivales posteriores)* (see also p. 802).

k) *A. dorsalis nasi* (O. T. nasal branch) (see Figs. 487 and 492) perforates the m. orbicularis oculi above the ligamentum palpebrale mediale, passes downward and anastomoses with the a. angularis (from the a. maxillaris externa).

l) *A. frontalis* (see Figs. 487, 488, 492 and 494) goes through the incisura frontalis to the forehead and supplies the muscles and skin in that situation.



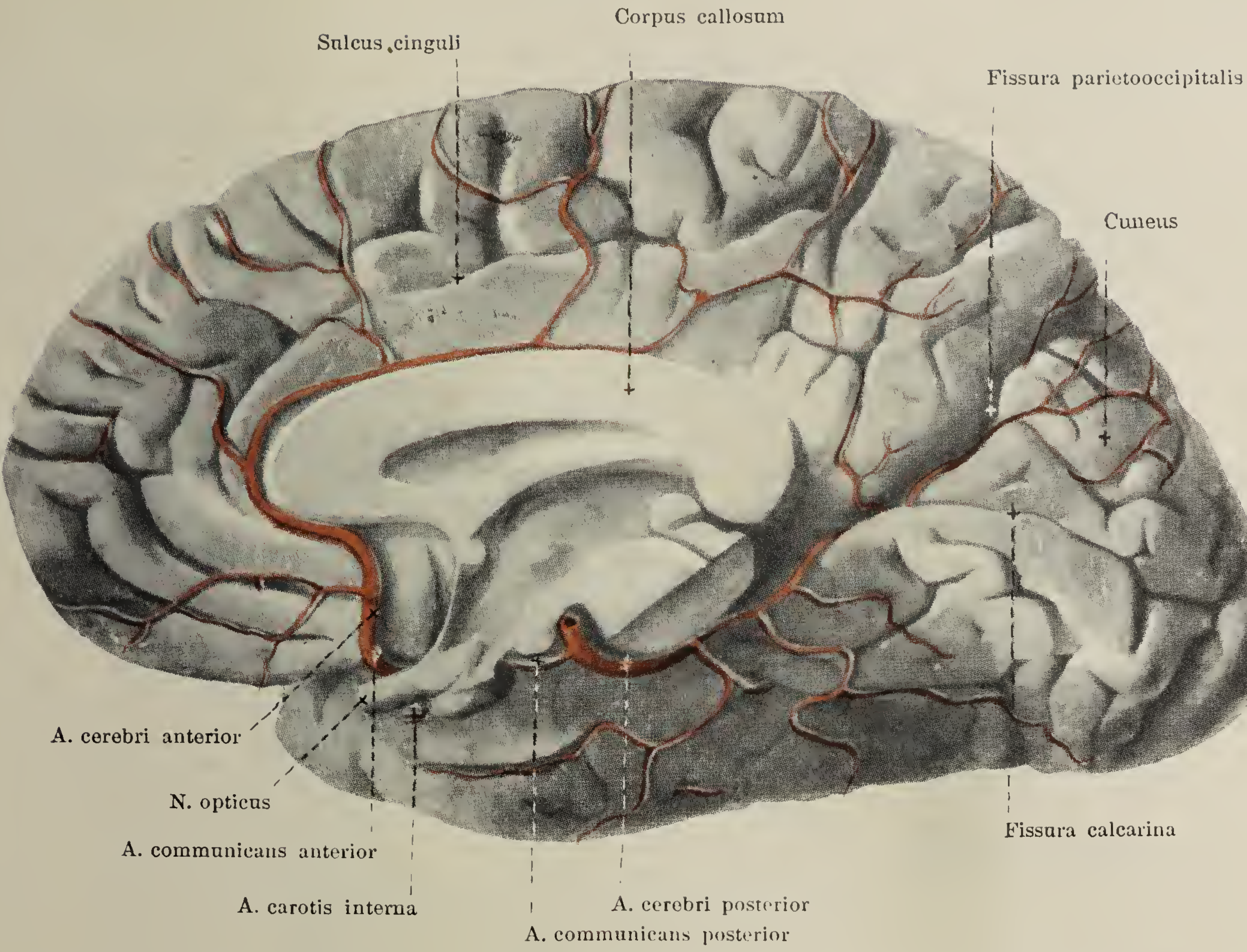
496. A. cerebri media and a. chorioidea of the right side, viewed from below.

(The temporal lobe and the occipital lobe have been removed to open up the cornu inferius ventriculi lateralis and to permit the fossa cerebri lateralis [Sylvii] to come into view; the cerebellum and the pons have been cut off just in front of their anterior margin.)

3. **A. communicans posterior** (posterior communicating artery) (see also Figs. 495, 497—499) passes backward over the sinus cavernosus, below the tractus opticus, lateralward from the tuber cinereum and the corpus mamillare, gives off small branches to the parts named and opens into the a. cerebri posterior (from the a. vertebralis).

4. **A. chorioidea** (O. T. anterior choroid artery (see also Fig. 495), delicate, goes between the tractus opticus and the gyrus hippocampi backward and lateralward to the cornu inferius of the lateral ventricle and breaks up in the plexus chorioideus ventriculi lateralis into branches; it sends besides small branches to the surrounding parts.

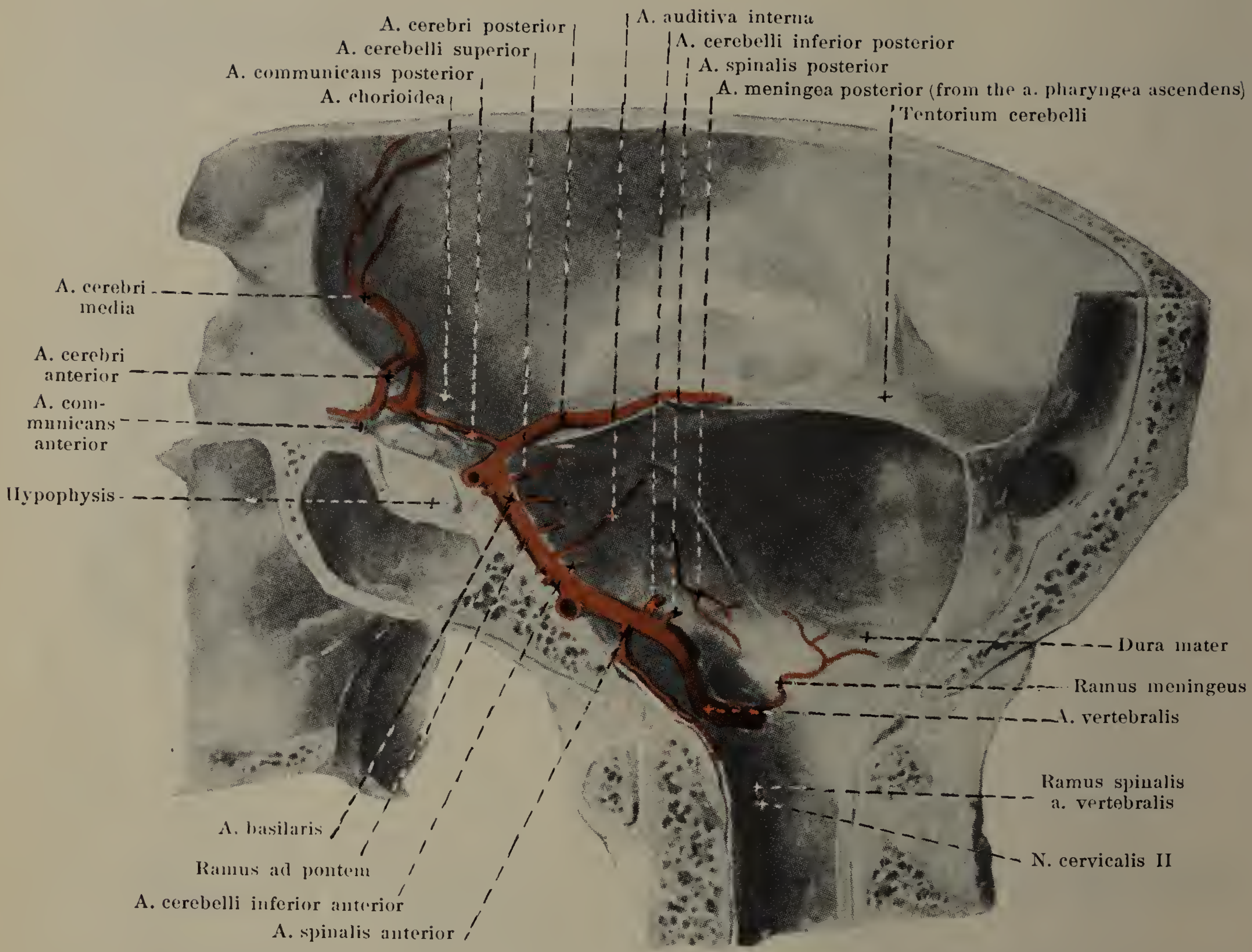
5. **A. cerebri media** (middle cerebral artery) (see also Figs. 495, 498 and 499) runs lateralward to the fossa cerebri lateralis [Sylvii] and in this to the lateral surface of the frontal, parietal and temporal lobe; it supplies the substantia perforata anterior, the lateral portion of the gyri orbitales, the island and the gyri frontalis inferior, centrales, the lobuli parietales, the gyri supramarginalis, angularis and temporalis superior; it is connected by numerous anastomoses with the aa. cerebri anterior and posterior.



497. Arteries of the medial surface of the right cerebral hemisphere.

6. **A. cerebri anterior** (see also Figs. 495, 496, 498 and 499) runs medianward above the n. opticus, sends branches to the cerebral ganglia through the substantia perforata anterior and to the chiasma opticum, approaches closely the vessel of the same name of the other side and forms a broad anastomosis with it by means of the *a. communicans anterior.* It next goes into the fissura longitudinalis cerebri around the genu corporis callosi, lying directly upon it, and passes backward upon the corpus callosum. It supplies the corpus callosum, the medial surface of the frontal and parietal lobes almost as far as the fissura parietooccipitalis, the gyrus rectus, the lobus olfactorius, the gyri orbitales as far as the medial limb of the sulci orbitales and the gyri frontales superior et medius and sends a branch to the falx cerebri. It communicates by numerous anastomoses with the aa. cerebri media and posterior.

A. subclavia (see Figs. 478, 485, 492 and 500) arises on the right side from the a. anonyma, on the left side directly from the arch of the aorta (see p. 407); the right is therefore shorter than the left, which ascends at first behind the v. anonyma sinistra, on the left side of the trachea. The artery runs on each side lateralward in a curve behind the m. sternocleidomastoideus over the pleural cupola and over the first rib, being convex upward. In front it is bounded at first by the v. subclavia (crossed in front by the ansa subclavia and the nn. vagus and phrenicus), then by the m. scalenus anterior, behind by the mm. scaleni minimus and medius and comes to lie in the scalenus fissure in the sulcus subclaviae of the first rib. From there on it goes, in the depth of the fossa supraclavicularis major, downward and lateralward to the axilla, behind and below the middle of the clavicle; it is bounded behind and above by the plexus brachialis and is covered by lymph glands and adipose tissue; the a. transversa scapulae crosses its anterior surface and the v. subclavia leans against it in front and below. From the lower margin of the m. subclavius (at the surgeons: of the m. pectoralis minor) on, its continuation is called the *a. axillaris.* Arising from it medianward from the m. scalenus anterior are the following branches: *a. vertebralis, a. mammaria interna* and the *truncus thyreocervicalis,* which again divides in a variable manner into the *a. thyreoidea inferior, a. cervicalis ascendens. a. cervicalis superficialis* and *a. transversa scapulae;* medially or dorsally from the m. scalenus anterior the *truncus costocervicalis* is given off, which divides into the *a. intercostalis suprema* and the *a. cervicalis profunda;* in the space between the mm. scaleni (sometimes a little lateralward from it) the *a. transversa colli* arises.



498. Arteries of the base of the brain in their relation to the base of the skull

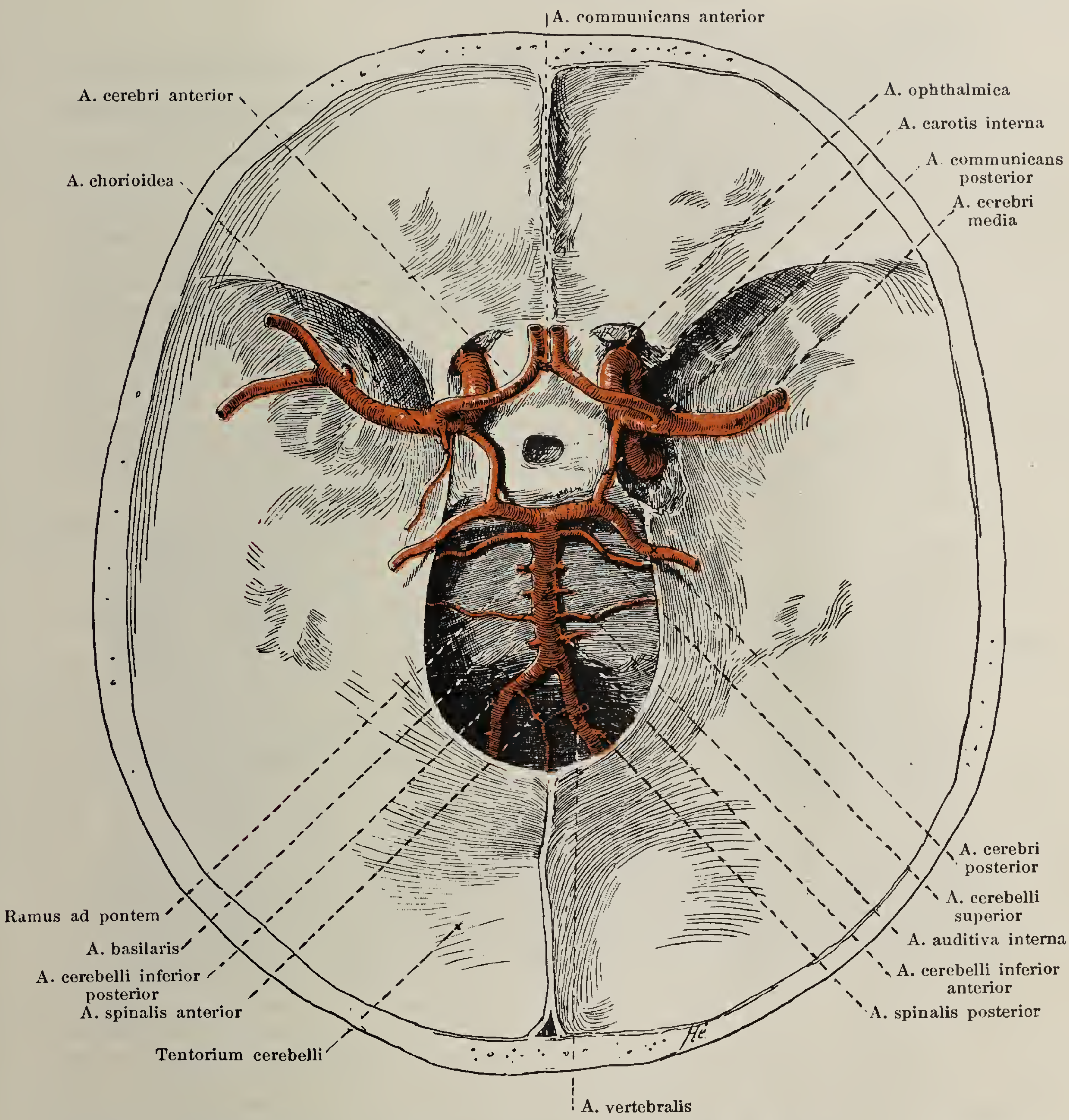
after removal of the brain; right half of the skull, viewed from the left. (The falx cerebri has been completely removed, the tentorium cerebelli partially. The a. meningea posterior and the ramus meningeus a. vertebralis have been drawn upon the dura mater.)

1. **A. vertebralis** (see Figs. 492, 495, 499 and 500), from the upper circumference of the a. subclavia, passes, at the lateral margin of the m. longus colli, lateralward and behind the a. carotis communis, curved slightly backward to the foramen transversarium of the 6th (sometimes the 5th, 4th, 3rd or 2nd, very seldom the 7th) cervical vertebra, then through the foramina transversaria of the 6th—2nd cervical vertebra, in front of the emerging cervical nerves, upward; it is next curved markedly lateralward to the foramen transversarium of the atlas and goes medianward in the sulcus arteriae vertebralis (see Figs. 267, 273 and 392) in a curve behind the massa lateralis atlantis, covered directly by the mm. obliquus capitis superior and rectus capitis posterior major. Between the atlas and os occipitale it then perforates the dura mater, bends upward, forward and medianward in front of the medulla oblongata to the clivus and unites on it acute angled with the vessel of the same name of the other side, approximately in front of the lower, posterior margin of the pons, to form the unpaired **a. basilaris.** This goes upward and forward upon the clivus in the sulcus basilaris of the pons and, at the upper, anterior margin of the pons, below the substantia perforata posterior and at the upper margin of the dorsum sellae, divides into its two terminal branches, the *aa. cerebri posteriores.* —

Branches of the a. vertebralis:

a) *Rami spinales*, from the cervical portion, go through the foramina intervertebralia to the canalis vertebralis and its contents. They give off branches to the neighboring muscles.

b) *Ramus meningeus* arises a little in front of the point where the vessel passes through the dura mater and extends, through the foramen magnum, upward to the dura mater of the posterior fossa of the skull.



499. Arteries of the base of the brain in their relation to the skull after removal of the brain; viewed from above. (On the right side the a. carotis interna has been exposed in its course in the sinus cavernosus.)

1. **A. vertebralis** (continued) (see also Figs. 495—497) (branches inside the dura mater):

c) *A. spinalis posterior*, delicate, bends around the lateral margin of the medulla oblongata and runs downward, forming anastomoses with that of the other side, in the sulcus lateralis posterior of the spinal cord, in front of and lateralward from the posterior roots; it unites with branches of the rami spinales of the a. vertebralis, aa. intercostales, lumbales and sacrales laterales and supplies the spinal cord and its membranes.

d) *A. spinalis anterior*, delicate, unites with the artery of the opposite side at the upper end of the spinal cord and runs downward, partly unpaired, partly plexiform being composed of one to four elongated meshes, in front of the fissura mediana anterior as far as the filum terminale; like the preceding artery it receives a variable number of branches of the rami spinales, and supplies the spinal cord and its membranes.

e) *A. cerebelli inferior posterior* (posterior inferior cerebellar artery) turns backward to the posterior part of the inferior surface of the cerebellum; it gives off branches to the plexus chorioideus ventriculi quarti.

Branches of the **a. basilaris** (see Figs. 495—499):

f) *A. cerebelli inferior anterior*, paired, runs lateralward to the anterior part of the inferior surface of the cerebellum.

g) *A. auditiva interna* (O. T. internal auditory artery) goes lateralward to the nn. facialis and acusticus and with these into the meatus acusticus internus (see p. 854).

h) *Rami ad pontem* (O. T. transverse or pontal arteries), numerous small branches, to the substance of the pons.

i) *A. cerebelli superior*, paired, arises shortly before the terminal subdivision, extends at the anterior, upper margin of the pons, lateral- and backward, forms a loop around the pedunculus cerebri so as to arrive upon the upper surface of the cerebellum and supplies mainly this region; it gives off branches to the plexus chorioideus ventriculi tertii.

k) *A. cerebri posterior* (posterior cerebral artery), paired, at first parallel to the preceding artery, separated from it by the n. oculomotorius and further lateralward by the n. trochlearis and by the tentorium cerebelli; it goes at the anterior margin of the pons around the pedunculus cerebri to the inferior surface of the occipital lobe. It gives off branches through the substantia perforata posterior to the cerebral ganglia, branches to the cerebral penduncles and to the plexus chorioideus ventriculi lateralis and supplies the whole occipital lobe and the temporal lobe with the exception of the gyrus temporalis superior. It communicates by numerous anastomoses with the aa. cerebri anterior and media.

The a. cerebri posterior receives near its origin the a. communicans posterior (from the a. carotis interna); in this way arises the *circulus arteriosus [Willisi]* (O. T. circle of Willis) which lies over the sella turcica and the diaphragma sellae and surrounds the chiasma opticum, the tuber cinereum and the corpora mamillaria.

2. **Truncus thyreocervicalis** (O. T. the thyroid axis) (see also Figs. 485 and 500) arises at the medial margin of the m. scalenus anterior from the anterior wall. Branches:

a) *A. thyreoidea inferior* runs, in front of the m. scalenus anterior, at first upward and then behind the v. jugularis interna, the n. vagus and the a. carotis communis in front of the a. vertebralis medianward and forward to the posterior surface of the glandula thyreoidea (see also Fig. 685), into which it penetrates *(rami glandulares)*; it gives off on its way the *rami pharyngei, oesophagei, tracheales*, as well as the *a. laryngea inferior* (see Fig. 486), which goes below the m. circopharyngeus into the larynx and anastomoses upon the lateral surface of the internal laryngeal muscles with the a. laryngea superior (from the a. thyreoidea superior).

b) *A. cervicalis ascendens*, usually a branch of a), ascends upon the origins of the mm. scaleni and levator scapulae, at first medianward from the n. phrenicus, behind the v. jugularis interna often going as far upward as the base of the skull; it gives off below several *rami spinales* into the foramina intervertebralia as well as *rami musculares* to the surrounding muscles; one of the latter, *ramus profundus* (see also Fig. 492), runs between the transverse processes of the 4th and 5th cervical vertebra backward to the deep muscles of the neck; it can take the place of the a. cervicalis profunda.

c) *A. cervicalis superficialis* goes behind the m. omohyoideus transversely through the fossa supraclavicularis major in front of the plexus brachialis and of the mm. scaleni and levator scapulae to the inner surface of the m. trapezius and supplies this and adjacent muscles. It alternates in its formation with the a. transversa colli.

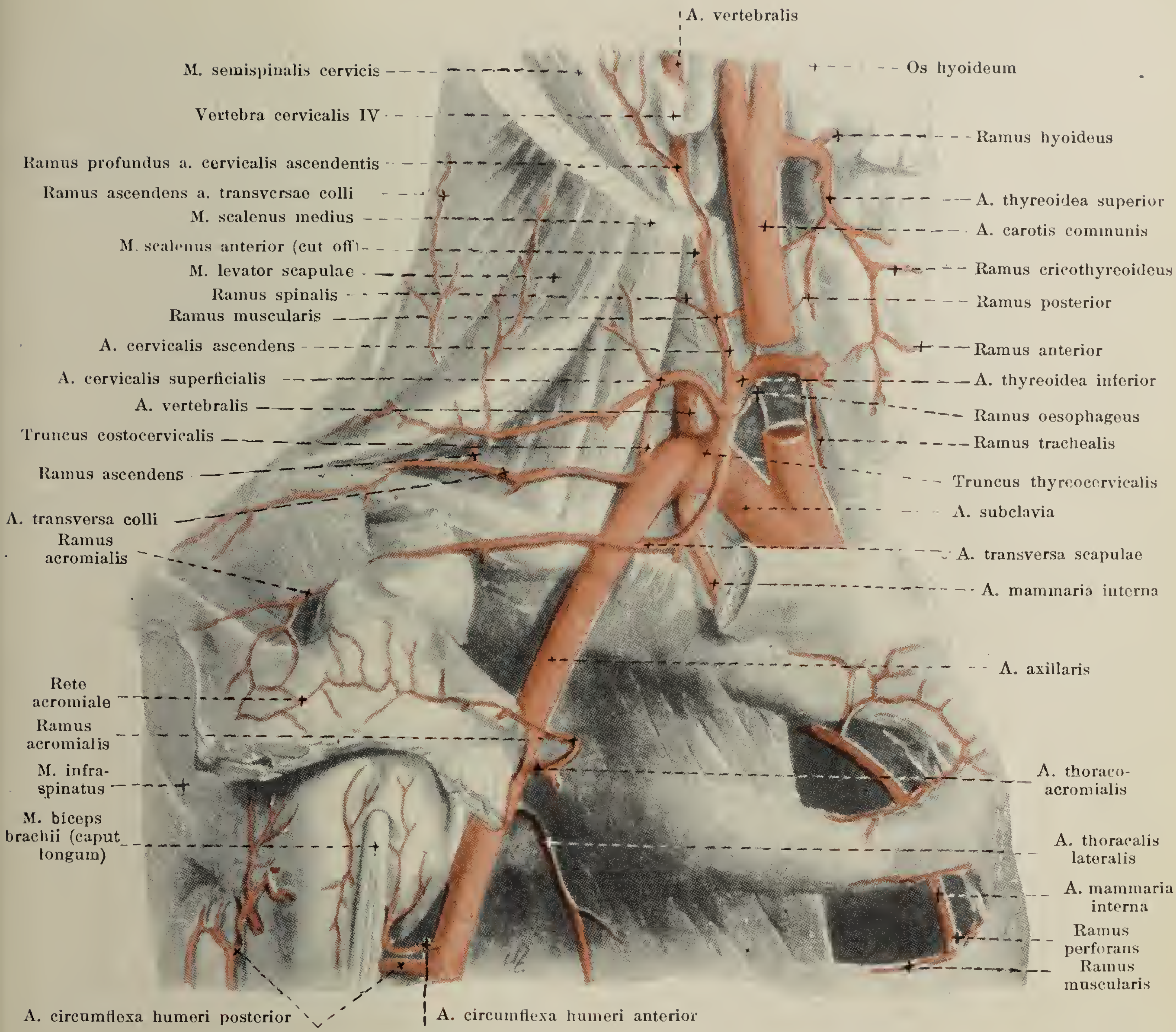
d) *A. transversa scapulae* (O. T. suprascapular or transversalis humeri) (see also Fig. 503) bends downward and forward, in front of the m. scalenus anterior, to the posterior surface of the clavicle and runs along this bone over the lig. transversum scapulae superius to the fossa supraspinata; it then runs behind the collum scapulae in front of the lig. transversum scapulae inferius to the fossa infraspinata, and there forms a broad anastomosis with the a. circumflexa scapulae. Near the incisura scapulae arises the *ramus acromialis*, which goes through the m. trapezius to the rete acromiale.

3. **A. mammaria interna** (internal mammary artery) (see also Fig. 501) goes from the inferior wall of the a. subclavia medianward and downward behind the v. subclavia directly upon the pleura and then vertically downward just behind the cartilages of the 1st—7th rib. It runs nearly parallel to the lateral margin of the sternum, is separated from it, increasing from above downward, one to two cm. and is covered behind by the pleura and by the m. transversus thoracis. In the region of the 6th intercostal space it divides into its two terminal branches: *a. musculophrenica* and *a. epigastrica superior*. Branches:

a) *Aa. mediastinales anteriores*, delicate branches, backward to the structures lying in the spatium mediastinale anterius.

b) *Aa. thymicae* (not illustrated), partly from neighboring vessels, backward to the thymus.

c) *Rami bronchialis* (not illustrated) to the lower end of the trachea and the bronchi; often absent.



500. A. subclavia dextra, viewed from the right.

(Most of the clavicle has been removed, as have been the muscles attached to the clavicle, the m. scalenus anterior and the mm. pectorales and deltoideus.)

3. **A. mammaria interna** (continued) (see also Fig. 501):

d) *A. pericardiacophrenica* with the n. phrenicus in front of the root of the lung on the pericardium downward to the diaphragm; it supplies the pericardium and the diaphragm.

e) *Rami sternales*, medianward to the posterior surface of the sternum; there they form a network of anastomoses with the vessels of the same name of the other side.

f) *Rami perforantes*, 6—7, the uppermost between the two heads of the m. sternocleidomastoideus (see Fig. 485) or between the clavicle and the first rib, the others forward through the uppermost 6 intercostal spaces. They supply the m. pectoralis major *(rami musculares)* and the skin of the front of the chest *(rami cutanei).* Among the latter that which comes from the 2nd intercostal space is usually very large, bends downward to the mamma and supplies it by means of the *rami mammarii.* The branch perforating the 6th intercostal space is also large and supplies the skin in front of the m. rectus abdominis as far as the navel.

g) *Rami intercostales*, two for each intercostal space, arise separately or two each from a little trunk. They run lateralward in the six upper intercostal spaces close to the ribs, supply the muscles and the pleura and anastomose with the aa. intercostales. The branch running at the lower margin of each rib is the larger one.

h) *A. musculophrenica* extends behind the cartilages of the 7th—10th (or 11th) rib, just over the origins of the pars costalis of the diaphragm, lateralward and downward; it gives off *rami intercostales* for the 7th—10th (or 11th) intercostal space and is distributed also in the diaphragm and in the abdominal muscles.

i) *A. epigastrica superior* passes between the processus xiphoideus and the 7th costal cartilage forward to the m. rectus abdominis, runs downward in it and anastomoses in the region of the navel with the a. epigastrica inferior; it gives off several small branches which go forward to the skin in the neighborhood of the navel.

4. **Truncus costocervicalis** (see also Figs. 492 and 512), from the posterior wall, divides after a short, upward course into two terminal branches:

a) *A. cervicalis profunda* (deep cervical artery), backward between the 1st rib and the proc. transversus of the 7th cervical vertebra, runs upon the mm. semispinalis cervicis and multifidus cervicis as far as the epistropheus. It supplies the muscles of the neck and, by a descending branch, the long muscles of the back; several branches into the intervertebral foramina.

b) *A. intercostalis suprema* (first intercostal artery) bends downward and backward in front of the neck of the first rib to the 1st intercostal space and also usually in front of the neck of the 2nd rib to the 2nd intercostal space. It gives off *rami posteriores* to the muscles and skin of the back and *rami spinales* into the foramina intervertebralia; in these branches and in its further course it behaves quite like the aa. intercostales (see p. 437).

5. **A. transversa colli** (O. T. transverse cervical artery or transversalis colli) (see Figs. 500 and 503), from the upper wall of the a. subclavia, runs among the branches of the plexus brachialis, usually between C_6 and C_7, directly upon the lateral surface of the m. scalenus medius, lateralward and backward and divides beneath the m. levator scapulae into its two terminal branches. It gives off a branch to the fossa supraspinata and supplies the muscles in the neighborhood of the same (see also p. 422).

a) *Ramus ascendens* extends upward under the m. levator scapulae and the mm. splenii in the neck to supply these muscles.

b) *Ramus descendens* passes downward between the mm. rhomboidei and the m. serratus posterior superior along the margo vertebralis of the scapula; it supplies these and the adjacent muscles and sends branches to the skin.

A. axillaris *(axillary artery)* (see Figs. 485, 500 and 502) runs distalward from the lower margin of the m. subclavius along the lateral angle of the axilla; it is covered at first by the proc. coracoideus, then lies in the groove behind the m. coracobrachialis and is bounded behind by the mm. subscapularis, latissimus dorsi and teres major, medianward by the m. serratus anterior. Superficially (medianward) it is covered by the v. axillaris; on the dorsal, lateral and ventral and partially also on the medial surface it is directly surrounded by the long branches of the plexus brachialis. From the lower margin of the m. pectoralis major on, its continuation is called the *a. brachialis.* Besides small branches to the m. subscapularis, *rami subscapulares,* it gives off the following branches:

1. **A. thoracalis suprema** (O. T. superior thoracic artery) (see Fig. 502) arises behind the m. subclavius and runs downward behind the m. pectoralis minor to the muscles of the 1st and 2nd intercostal space; it may be substituted by a branch of the a. thoracoacrominalis.

2. **A. thoracoacrominalis** (O. T. acromiothoracic or thoracic axis) (see Figs. 485, 500 and 502) arises at the upper margin of the m. pectoralis minor and ends in *rami pectorales* between the mm. pectorales. Branches:

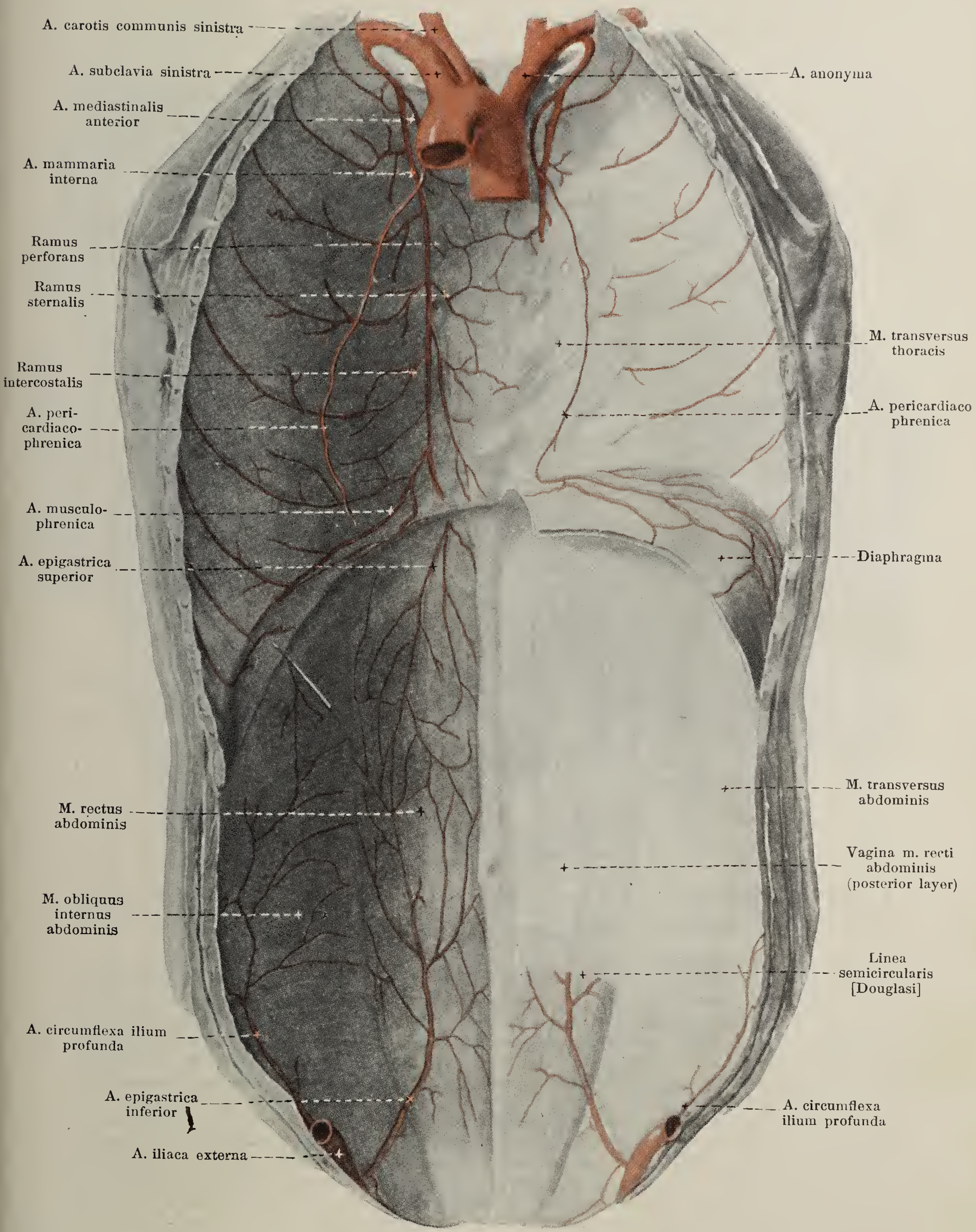
a) *Ramus acromialis,* transversely behind the mm. pectoralis major and deltoideus, in front of the proc. coracoideus, lateralward, supplies these muscles, perforates the m. deltoideus and ends in the *rete acromiale,* situated upon the upper surface of the acromion.

b) *Ramus deltoideus* goes downward in the slit between the mm. pectoralis major and deltoideus; it supplies especially the latter muscle and the skin over it.

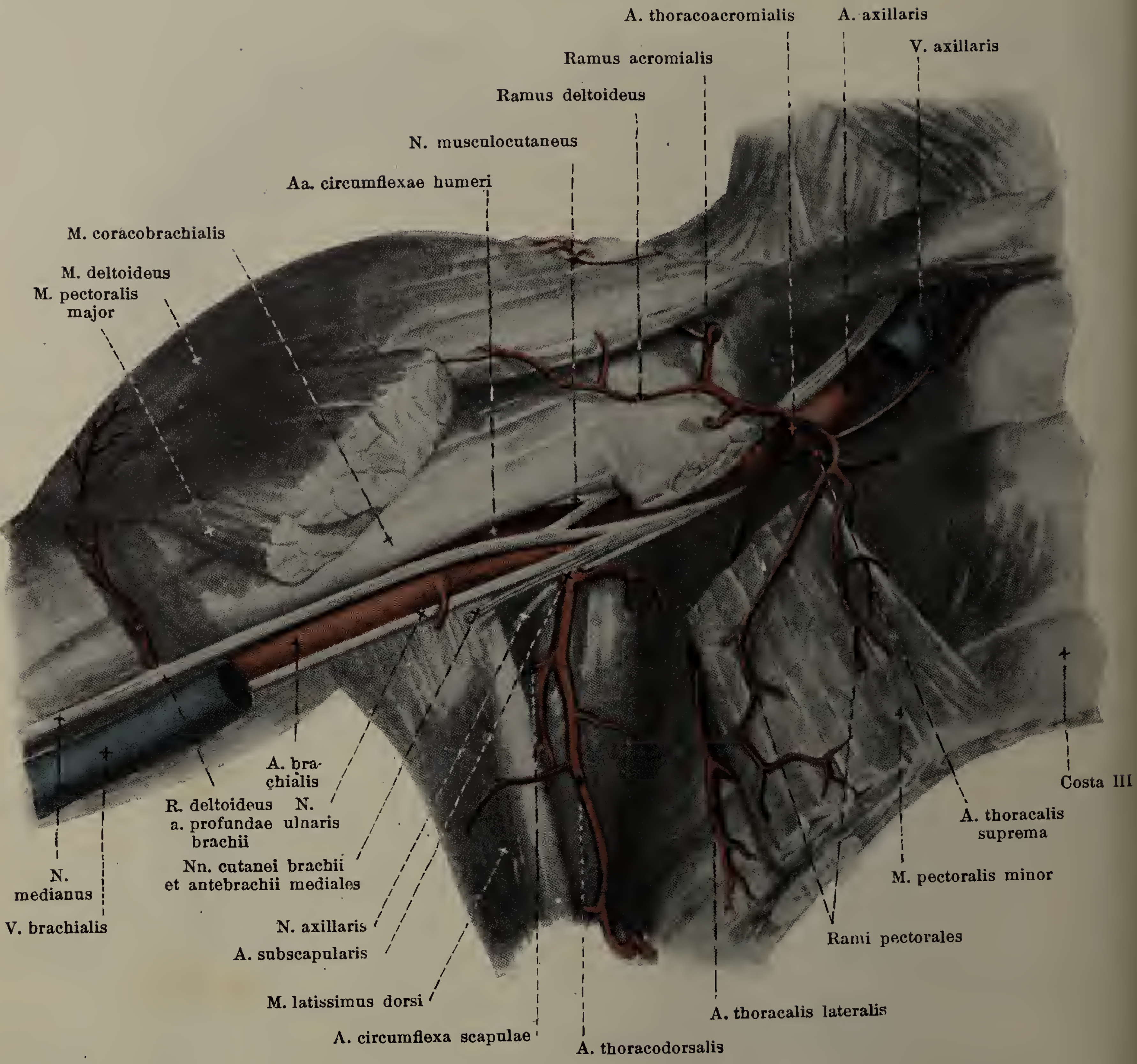
3. **A. thoracalis lateralis** (O. T. long thoracic artery) (see Figs. 500 und 502) arises behind the m. pectoralis minor and runs upon the m. serratus anterior downward as far as the 5th or 6th intercostal space; it supplies especially the m. serratus anterior. Several branches *(rami mammarii externi)* go through the m. pectoralis major to the skin of the mammary region. It is often a branch of the a. subscapularis.

4. **A. subscapularis** (see Figs. 502 and 503), arises at the lower margin of the m. subscapularis (see also p. 426), goes downward and soon divides into two terminal branches:

a) *A. circumflexa scapulae* (O. T. dorsalis scapulae) bends backward between the mm. subscapularis and teres major through the medial axillary space and then, medial from the caput longum of the m. triceps, goes upward, partly in front of, partly behind the m. teres minor, into the fossa infraspinata. It supplies the neighboring muscles and skin and anastomoses freely with the a. transversa scapulae.



501. Arteries of the anterior wall of the trunk, viewed from behind.
On the left the mm. transversi thoracis and abdominis as well as the posterior leaf of the sheath of the m. rectus have been removed.)
(The aa. epigastricae are drawn upon the surface of the mm. recti abdominis.)



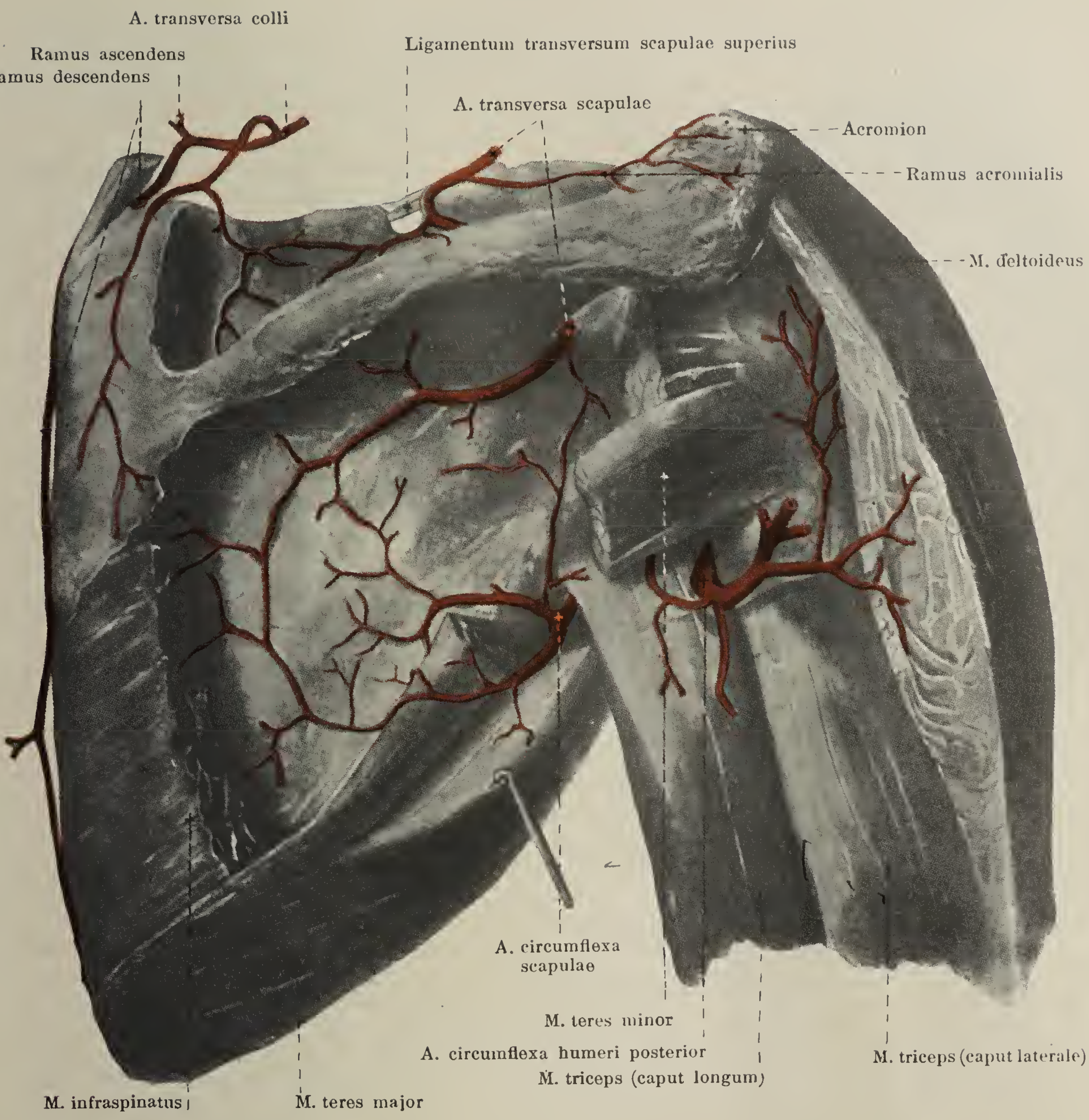
502. Arteries of the right axilla, viewed from in front.
(The arm is lifted, the mm. pectorales have been partially removed.)

4. **A. subscapularis** (continued):

b) *A. thoracodorsalis,* between the mm. latissimus dorsi and serratus anterior along the margo axillaris scapulae downward and backward, supplies the neighboring muscles and skin.

5. **A. circumflexa humeri anterior** (O. T. anterior circumflex artery) (see Fig. 500) (generally slighter than the following) goes, directly on the anterior surface of the collum chirurgicum humeri, covered by all the muscles, first lateralward, then backward. It supplies these muscles, the shoulder joint and by means of 1—2 branches *(aa. nutriciae humeri)* the superior epiphysis.

6. **A. circumflexa humeri posterior** (O.T. posterior circumflex artery) (see Figs. 500, 503 and 505) arises at the same level as the preceding artery, sometimes in common with it and is not rarely a branch of the a. subscapularis (occasionally arising from a trunk from which originate also the a. subscapularis and a. profunda brachii), passes with the n. axillaris backward through the lateral axillary space between the humerus, mm. subscapularis and teres minor, caput longum m. tricipitis as well as mm. latissimus dorsi and teres major and surrounds the collum chirurgicum from behind and lateralward, lying always upon the bone and covered by all the muscles. It supplies these muscles, the shoulder joint and the skin over the m. deltoideus; it usually gives off two branches *(aa. nutriciae humeri)* to the superior epiphysis of the humerus.

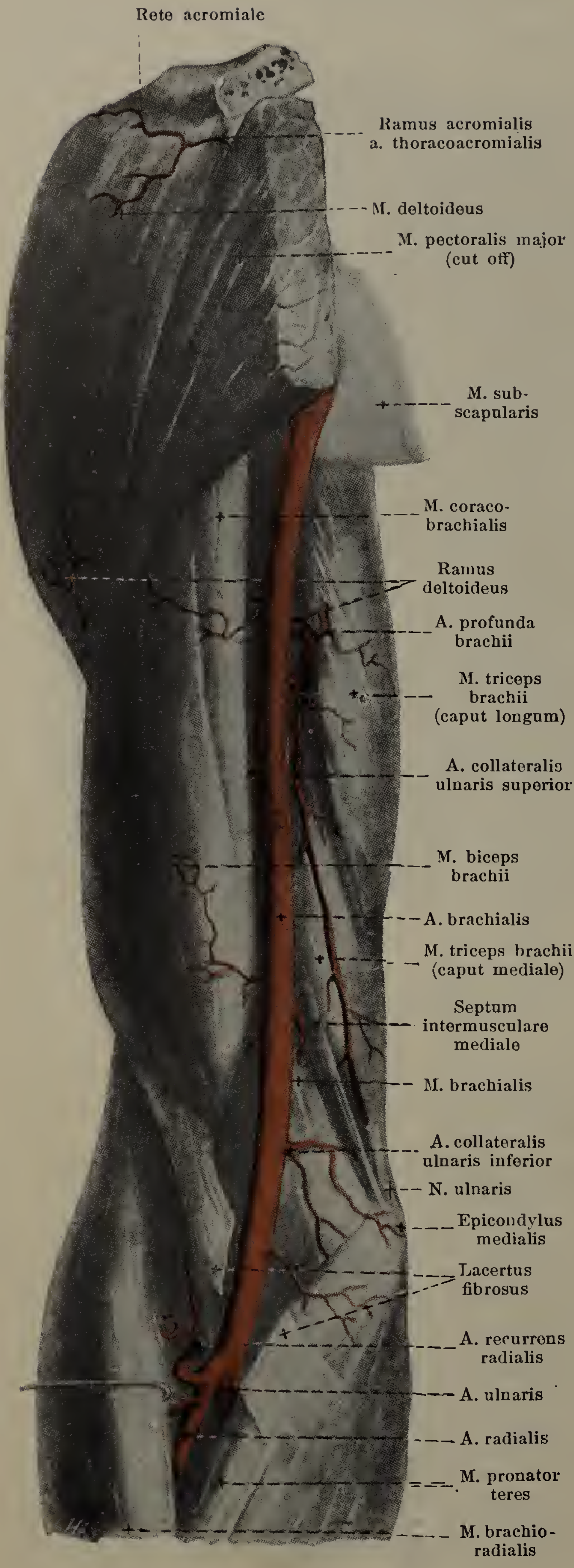


503. Arteries of the right shoulder-blade, viewed from behind.

(The mm. supraspinatus, infraspinatus, teres minor and deltoideus have been partially removed.)

A. brachialis *(brachial artery)* (see Figs. 502, 504, 506 and 507) extends from the inferior margin of the m. pectoralis major onward, at first just behind the m. coracobrachialis, in front of the caput longum and caput mediale of the m. triceps, then in the sulcus bicipitalis medialis almost straight downward; it then passes upon the m. brachialis, covered by the lacertus fibrosus, to the depth of the elbow, there to divide at the level of the proc. coronoideus ulnae into the *a. radialis* and the *a. ulnaris.* Superficial to it medianward and in front of it run the vv. brachiales; on its lateral anterior surface above descends the n. medianus, which, however, above the elbow passes in front of the artery to its medial side; on its medial surface lies above the n. ulnaris, on its posterior surface the n. radialis; these, however, soon diverge from it. Besides several small branches to the neighboring muscles and skin it gives off:

1. **A. profunda brachii** (O. T. superior profunda artery) (see Figs. 504 and 505) arises from the upper portion of the vessel, bends backward and downward and follows a spiral course along with the n. radialis in the sulcus n. radialis around the posterior surface of the humerus downward and lateralward; in its course it runs between the origins of the caput laterale and caput mediale m. tricipitis and is covered by the former. Branches:



504. Arteries of the right upper arm,

viewed from in front.

1. **A. profunda brachii** (continued) (see also Fig. 505):

a) *Ramus deltoideus* (see also Fig. 502) goes off immediately below the origin of the artery or arises from the a. brachialis or from the a. collateralis ulnaris superior; it runs lateralward, transversely over the anterior surface of the humerus, covered by the mm. coracobrachialis and biceps, to the m. deltoideus and gives off branches to this and to the m. brachialis.

b) *A. collateralis media* runs downward in the substance of the caput mediale of the m. triceps and sometimes reaches the rete articulare cubiti, which it then helps to form.

c) *A. collateralis radialis* (O. T. articular branch of the superior profunda) appears somewhat below the middle of the upper arm between the caput laterale and the caput mediale of the m. triceps (with the n. cutaneus antebrachii dorsalis of the n. radialis), runs just behind the septum intermusculare laterale as far as the epicondylus lateralis and there opens into the rete articulare cubiti. It supplies the neighboring muscles, the skin over the m. triceps and partly also that over the mm. brachialis and biceps.

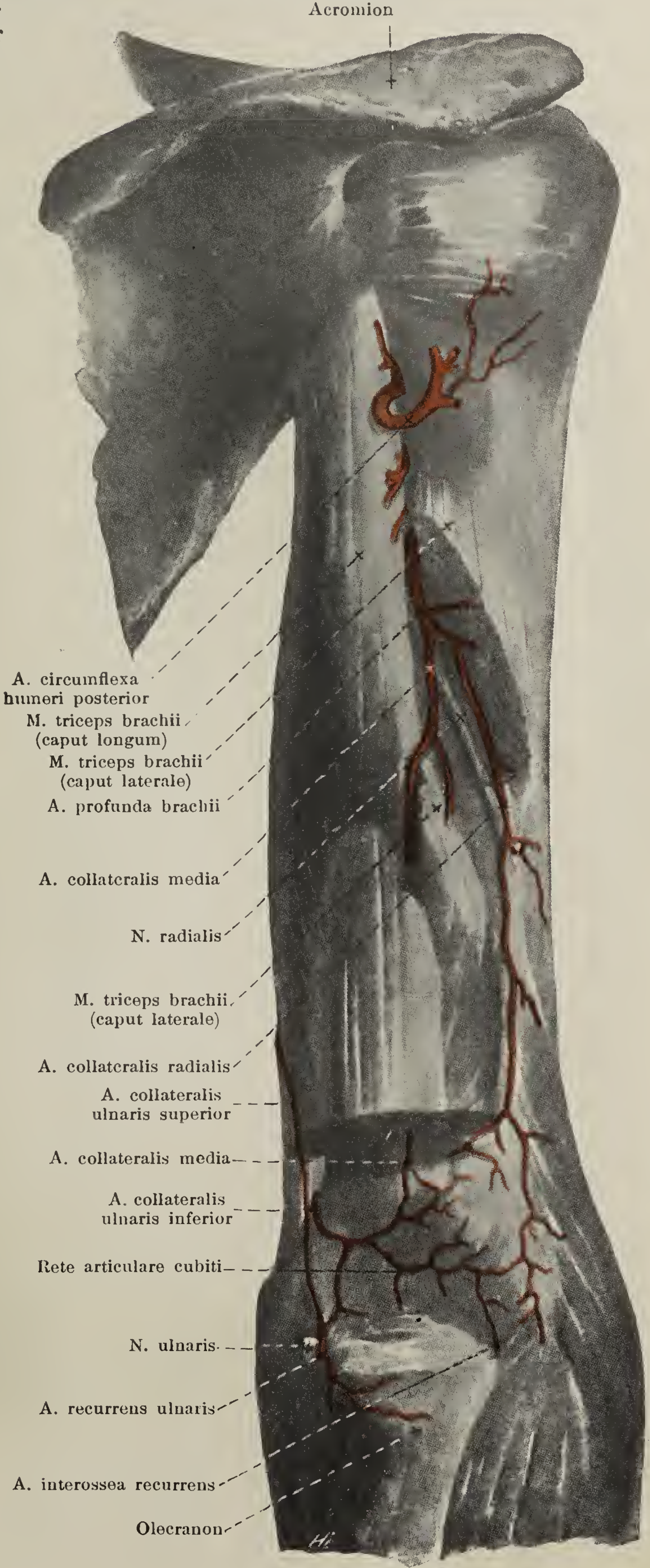
d) *A. nutricia humeri* (not illustrated) arises sometimes also from a muscular branch or from the a. brachialis itself; it passes through the canalis nutricius to the bone and marrow of the diaphysis.

2. **A. collateralis ulnaris superior** (O. T. inferior profunda artery) (see also Figs. 505—507) arises usually a little below the preceding artery, runs downward with the n. ulnaris on the medial surface of the caput mediale m. tricipitis (behind the septum intermusculare mediale) and enters into the rete articulare cubiti near the olecranon. It supplies the neighboring muscles and skin.

3. **A. collateralis ulnaris inferior** (O. T. anastomotica magna artery) (see also Figs. 505—508) goes off somewhat above the epicondylus medialis humeri, runs medianward in front of the m. brachialis, perforates the septum intermusculare mediale, bends directly upon the bone backward and lateralward and enters into the rete articulare cubiti; it gives off branches to the adjacent muscles.

505. Arteries of the right upper arm, viewed from behind.

(The m. triceps has been partially removed, the other muscles of the upper arm have been completely removed.)

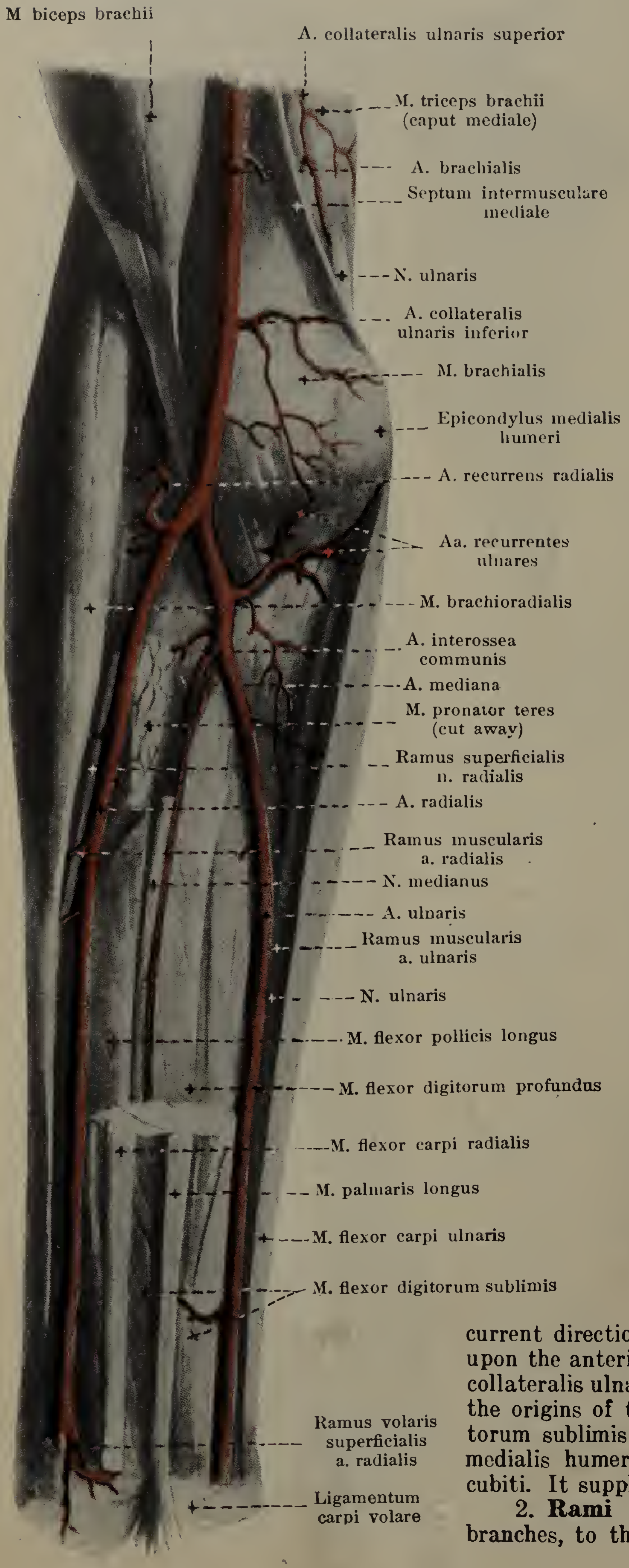

Acromion
A. circumflexa humeri posterior
M. triceps brachii (caput longum)
M. triceps brachii (caput laterale)
A. profunda brachii
A. collateralis media
N. radialis
M. triceps brachii (caput laterale)
A. collateralis radialis
A. collateralis ulnaris superior
A. collateralis media
A. collateralis ulnaris inferior
Rete articulare cubiti
N. ulnaris
A. recurrens ulnaris
A. interossea recurrens
Olecranon
Hi

A. radialis *(radial artery)* (see also Figs. 504, 506—511) extends radialward, slightly curved, upon the m. supinator and then runs almost straight to the wrist between the m. brachioradialis on one side, the mm. pronator teres and flexor carpi radialis on the other side; it is covered over in its upper portion by the margin of the m. brachioradialis and, below, lies free, covered only by the fascia antebrachii; above it lies, in its course, upon the insertion of the m. pronator teres, below first upon the mm. flexor digitorum sublimis and flexor pollicis longus; then upon the m. pronator quadratus or the radius and is accompanied in the upper half at its radial side by the ramus superficialis n. radialis. Distalward from the proc. styloideus radii it bends to the back of the hand, covered by the tendons of the mm. abductor pollicis longus and extensor pollicis brevis, then runs distalward through the tabatière and beneath the tendon of the m. extensor pollicis longus, passes between the bases of the ossa metacarpalia I and II through the m. interosseus dorsalis I into the palm and ends in the arcus volaris profundus. Branches:

1. **A. recurrens radialis** (O. T. radial recurrent artery) (see Fig. 507) goes off directly after the artery arises, bends upward and backward like a hook along the n. radialis upon the m. supinator; it supplies the adjacent muscles and the skin over them and sends off a branch beneath the origin of the m. brachioradialis through the septum intermusculare laterale into the rete articulare cubiti (see Fig. 508).
2. **Rami musculares** (see Fig. 506) in the forearm, numerous, to the adjacent muscles and to the skin.
3. **Ramus volaris superficialis** (Q.T. superficial volar branch) (see Fig. 510) arises at the level of the proc. styloideus radii, runs distalward upon or partly between the bundles of the m. abductor pollicis brevis, otherwise covered only by the thin fascia of the thenar, and goes over usually in the form of a curve into the *arcus volaris superficialis*. It gives off branches to the muscles and skin of the thumb.

506. Arteries of the right forearm,

viewed from in front, 1st layer.


M biceps brachii
A. collateralis ulnaris superior
M. triceps brachii (caput mediale)
A. brachialis
Septum intermusculare mediale
N. ulnaris
A. collateralis ulnaris inferior
M. brachialis
Epicondylus medialis humeri
A. recurrens radialis
Aa. recurrentes ulnares
M. brachioradialis
A. interossea communis
A. mediana
M. pronator teres (cut away)
Ramus superficialis n. radialis
A. radialis
Ramus muscularis a. radialis
N. medianus
A. ulnaris
Ramus muscularis a. ulnaris
N. ulnaris
M. flexor pollicis longus
M. flexor digitorum profundus
M. flexor carpi radialis
M. palmaris longus
M. flexor carpi ulnaris
M. flexor digitorum sublimis
Ramus volaris superficialis a. radialis
Ligamentum carpi volare

(The mm. pronator teres, palmaris longus, flexor carpi radialis and flexor digitorum sublimis have been partially removed from their origins.)

4. **Ramus carpeus volaris** (O. T. anterior radial carpal) (see Figs. 507 and 511), delicate, goes ulnarward at the distal margin of the m. pronator quadratus, directly upon the bone; it helps to form the *rete carpi volare.*

5. **Ramus carpeus dorsalis** (O. T. posterior radial carpal) (see Figs. 508 and 509) arises from the portion of the artery situated in the back of the hand, extends ulnarward directly upon the bones and ligaments and helps to form the *rete carpi dorsale.*

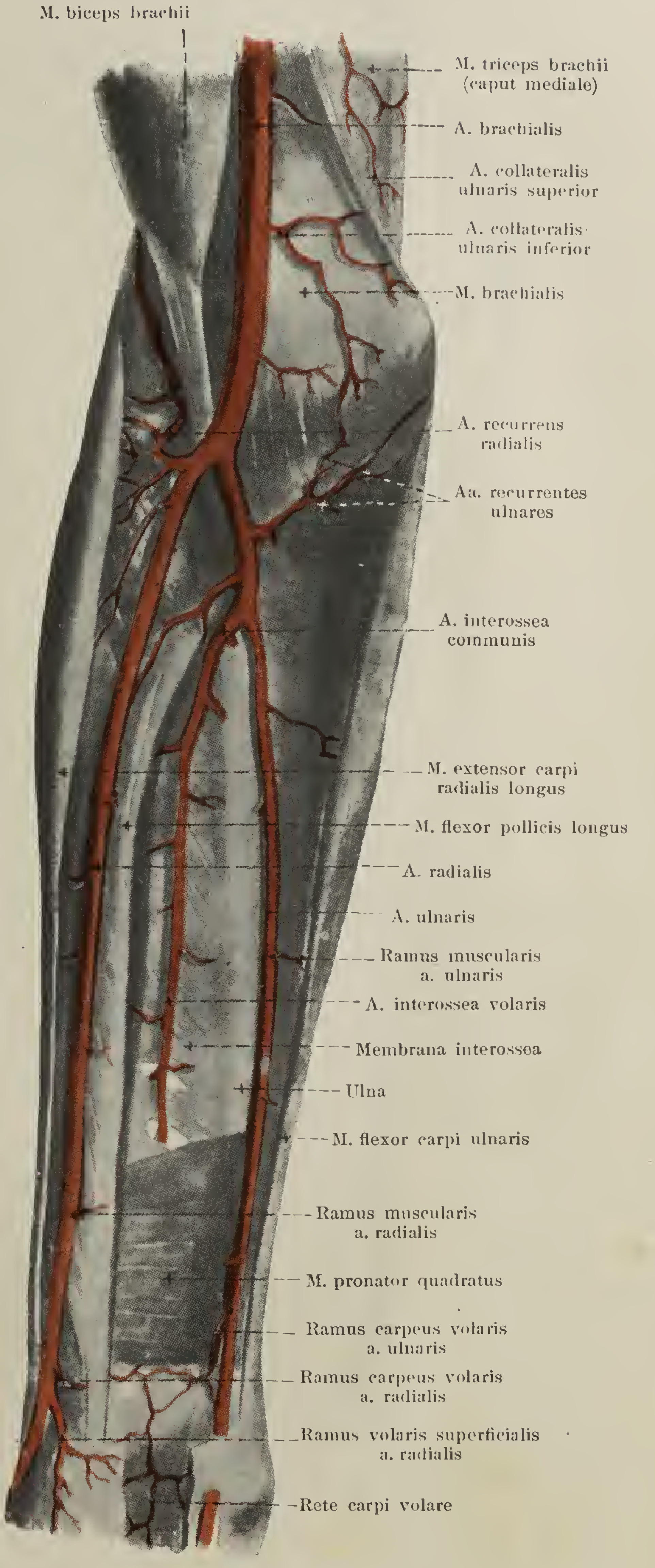
6. **A. metacarpea dorsalis I** (O. T. dorsalis indicis or dorsal artery of the first finger) (see Fig. 509) goes off shortly before the passage of the artery through the m. interosseus dorsalis I, divides soon afterward and supplies the adjacent margins of the index finger (as far as the first phalanx) and thumb. A small branch to the radial margin of the thumb usually arises separately.

A. ulnaris *(ulnar artery) (see also* Figs. 504, 507—511) goes into the depth at the upper margin of the m. pronator teres and then turns ulnarward beneath this as well as beneath the mm. flexor carpi radialis, palmaris longus and flexor digitorum sublimis, directly upon the m. flexor digitorum profundus; it then runs along the volar margin of the m. flexor carpi ulnaris, between it and the m. flexor digitorum sublimis to the wrist. It is hidden in its course beneath the margins of the neighboring muscles, is accompanied ulnarward for part of the way by the n. ulnaris and rests upon the m. flexor digitorum profundus. In the hand it runs beneath the lig. carpi volare, then upon the lig. carpi transversum on the radial side of the os pisiforme and ends in the arcus volaris superficialis. Branches:

1. **Aa. recurrentes ulnares** (O. T., ulnar recurrent arteries) (see also Fig. 505), single or in a common trunk from the beginning of the artery; they run in a recurrent direction, that is, proximalward; one runs usually upon the anterior surface of the m. brachialis toward the a. collateralis ulnaris inferior, the other runs backward beneath the origins of the mm. flexor carpi radialis and flexor digitorum sublimis to the sulcus n. ulnaris of the epicondylus medialis humeri and there enters into the rete articulare cubiti. It supplies the surrounding muscles and skin.

2. **Rami musculares,** in the forearm, numerous branches, to the surrounding muscles and to the skin.

507. Arteries of the right forearm, viewed from in front, 2nd layer.


M. biceps brachii
M. triceps brachii (caput mediale)
A. brachialis
A. collateralis ulnaris superior
A. collateralis ulnaris inferior
M. brachialis
A. recurrens radialis
Aa. recurrentes ulnares
A. interossea communis
M. extensor carpi radialis longus
M. flexor pollicis longus
A. radialis
A. ulnaris
Ramus muscularis a. ulnaris
A. interossea volaris
Membrana interossea
Ulna
M. flexor carpi ulnaris
Ramus muscularis a. radialis
M. pronator quadratus
Ramus carpeus volaris a. ulnaris
Ramus carpeus volaris a. radialis
Ramus volaris superficialis a. radialis
Rete carpi volare

(The mm. brachioradialis, pronator teres, flexor carpi radialis and flexores digitorum sublimis et profundus have been removed.)

3. **Ramus carpeus volaris** (O. T. anterior ulnar carpal) (see also Fig. 511), usually double, delicate, goes in the neighborhood of the wrist, upon the bone, to the *rete carpi volare.*

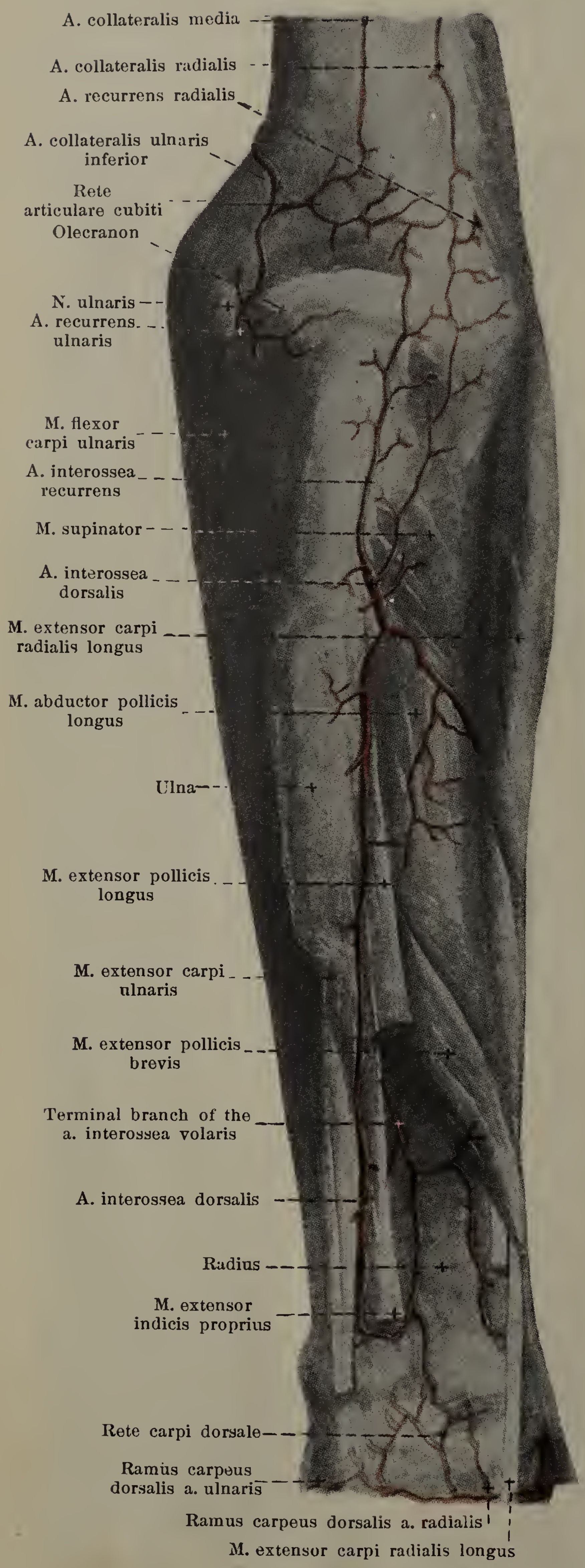
4. **Ramus carpeus dorsalis** (O. T. posterior ulnar carpal) (see Figs. 508, 509 and 511) runs, directly upon the bone, around the ulna to the back of the hand and to the *rete carpi dorsale.*

5. **Ramus volaris profundus** (O. T. deep ulnar artery) (see Figs. 510 and 511) arises close to the os pisiforme, goes into the depth between the origins of the mm. flexor digiti V brevis and abductor digiti V through the origin of the m. opponeus digiti V and helps to form the *arcus volaris profundus;* it gives off small branches to the muscles of the hypothenar. From this branch, or from the stem of the a. ulnaris itself, an artery *(a. digitalis volaris)* passes beneath the m. palmaris brevis upon the muscles of the hypothenar (giving branches to these and to the skin) to the ulnar margin of the 5th finger.

6. **A. interossea communis** (O. T. common interosseous artery) (see also Fig. 506) goes off a little below the tuberositas radii and divides immediately into two branches:

a) *A. interossea volaris* (O. T. anterior interosseus artery) runs distalward directly upon the volar surface of the membrana interossea, covered by the m. flexor digitorum profundus; it supplies the muscles of the volar surface and sends a series of branches through the membrane to the muscles of the posterior surface; it also sends branches *(aa. nutriciae)* to the radius and ulna. It reaches the dorsal surface of the membrana interossea at the upper margin of the m. pronator quadratus and runs distalward upon it to the rete carpi dorsale (see Figs. 508 and 509); a small branch remains upon the volar surface and goes to the rete carpi volare (see also Fig. 511). Branch:

aa) *A. mediana* (O. T. median artery or arteria comes nervi mediani) (see Fig. 506) from the first portion of the artery, often directly from the a. ulnaris, slender runs at the ulnar side of the n. medianus distalward, finally to reach the palm.


A. collateralis media
A. collateralis radialis
A. recurrens radialis
A. collateralis ulnaris inferior
Rete articulare cubiti
Olecranon
N. ulnaris
A. recurrens ulnaris
M. flexor carpi ulnaris
A. interossea recurrens
M. supinator
A. interossea dorsalis
M. extensor carpi radialis longus
M. abductor pollicis longus
Ulna
M. extensor pollicis longus
M. extensor carpi ulnaris
M. extensor pollicis brevis
Terminal branch of the a. interossea volaris
A. interossea dorsalis
Radius
M. extensor indicis proprius
Rete carpi dorsale
Ramus carpeus dorsalis a. ulnaris
Ramus carpeus dorsalis a. radialis
M. extensor carpi radialis longus

508. Arteries of the right forearm, viewed from behind.

(The m. extensor digitorum communis has been completely removed, the mm. extensores carpi, indicis proprius, digiti V proprius partially.)

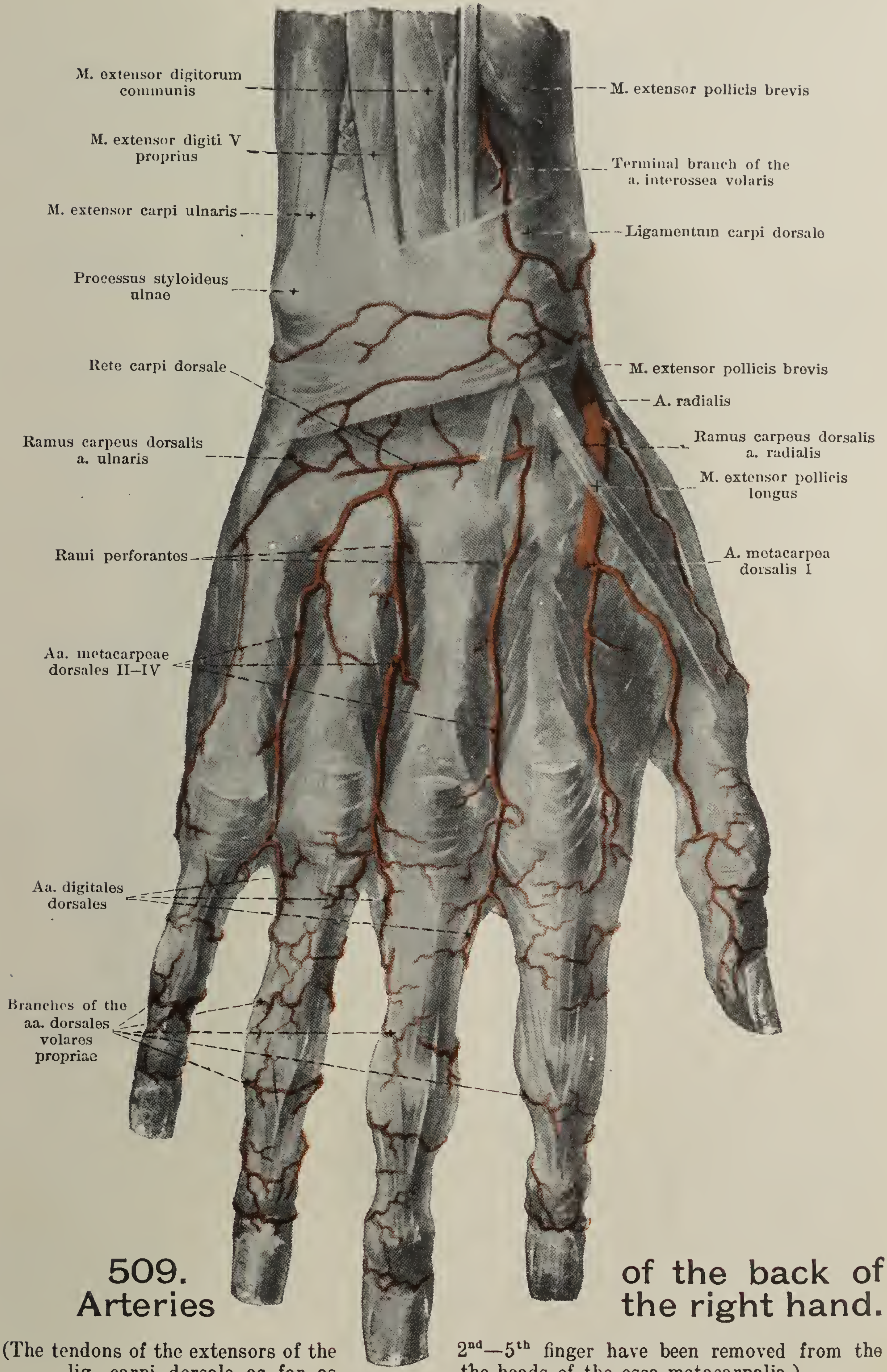
6. **A. interossea communis** (continued):

b) ***A. interossea dorsalis*** (O. T. posterior interosseous artery) perforates the membrana interossea a little below the chorda obliqua, appears at the lower margin of the origin of the m. supinator and then runs almost straight distalward upon the ulnar origins of the mm. abductor pollicis longus, extensor pollicis longus and extensor indicis proprius. It is distributed to the adjacent muscles and skin and ends in the rete carpi dorsale. Branch:

ba) *A. interossea recurrens* (O. T. interosseous recurrent or posterior interosseous recurrent) runs upward upon or near the m. supinator (covered by the m. anconaeus), gives off branches to both muscles and to the skin covering them and goes to the rete articulare cubiti.

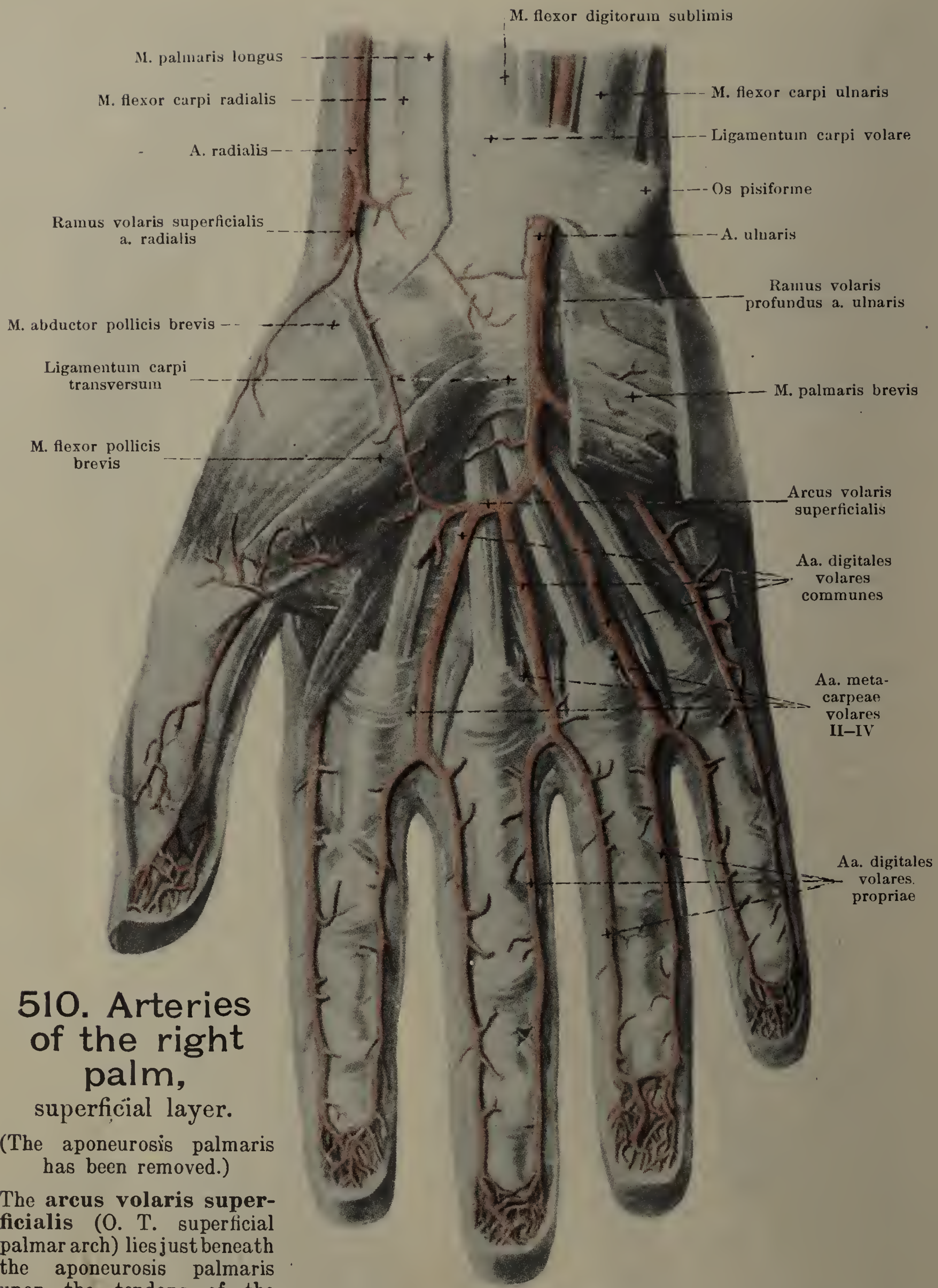
Rete articulare cubiti (see also Fig. 505) is a wide vascular network, situated especially on the dorsal surface of the elbow joint, in part more superficially upon the olecranon and the tendon of the m. triceps, in part deeper between this tendon, the humerus and the elbow joint. Opening into it from above are the aa. collaterales ulnares superior et inferior, collateralis media and collateralis radialis, from below large branches from the posterior a. recurrens ulnaris and the a. interossea recurrens and small branches from the a. recurrens radialis. A little above the capsule of the joint there is usually a large, transverse anastomosis, which is fed especially by the a. collateralis ulnaris inferior. Branches go off from the network to the surrounding bones, joints, muscles and skin.

Rete carpi dorsale (O. T. posterior carpal rete) (see also Fig. 509) lies upon the back of the wrist and is arranged in two layers: one more superficial, consisting of finer vessels, upon the lig. carpi dorsale and one deeper, directly upon the ligaments and bones of the wrist. The rete is formed by the rami carpei dorsales of the a. radialis and of the a. ulnaris, as well as by the terminal branches of the aa. interosseae volaris et dorsalis. From the deep part of the network arise the ***aa. metacarpeae dorsales*** (O. T. dorsal interosseous arteries) II, III and IV, which run distalward upon the mm. interossei dorsales II, III and IV, one upon each, each dividing at the level of the heads of the ossa metacarpalia into 2 ***aa. digitales dorsales*** (O. T. dorsal digital arteries) for the adjacent margins of the 2nd to the 5th finger. The latter vessels are short and usually end at the first finger-joints. A vessel arises usually directly from the network for the ulnar margin of the little finger. The aa. metacarpeae dorsales receive the rami perforantes of the aa. metacarpeae volares.


M. extensor digitorum communis
M. extensor digiti V proprius
M. extensor carpi ulnaris
Processus styloideus ulnae
Rete carpi dorsale
Ramus carpeus dorsalis a. ulnaris
Rami perforantes
Aa. metacarpeae dorsales II—IV
Aa. digitales dorsales
Branches of the aa. dorsales volares propriae
M. extensor pollicis brevis
Terminal branch of the a. interossea volaris
Ligamentum carpi dorsale
M. extensor pollicis brevis
A. radialis
Ramus carpeus dorsalis a. radialis
M. extensor pollicis longus
A. metacarpea dorsalis I

509.
Arteries of the back of the right hand.

(The tendons of the extensors of the 2nd—5th finger have been removed from the lig. carpi dorsale as far as the heads of the ossa metacarpalia.)

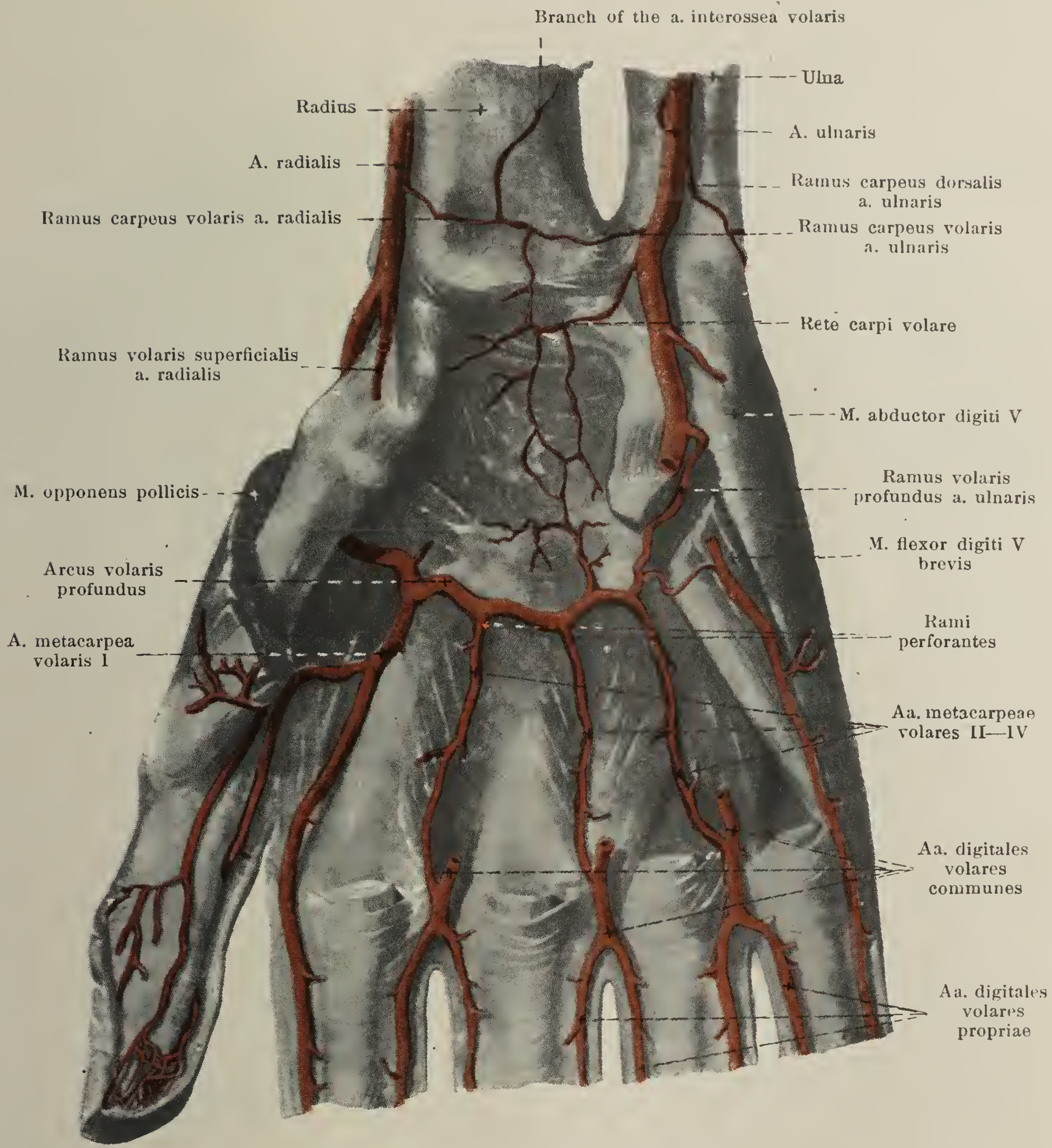

M. flexor digitorum sublimis
M. palmaris longus
M. flexor carpi radialis
A. radialis
Ramus volaris superficialis a. radialis
M. abductor pollicis brevis
Ligamentum carpi transversum
M. flexor pollicis brevis
M. flexor carpi ulnaris
Ligamentum carpi volare
Os pisiforme
A. ulnaris
Ramus volaris profundus a. ulnaris
M. palmaris brevis
Arcus volaris superficialis
Aa. digitales volares communes
Aa. metacarpeae volares II–IV
Aa. digitales volares propriae

510. Arteries of the right palm,

superficial layer.

(The aponeurosis palmaris has been removed.)

The **arcus volaris superficialis** (O. T. superficial palmar arch) lies just beneath the aponeurosis palmaris upon the tendons of the m. flexor digitorum sublimis; its convexity is directed distalward. It is formed chiefly by the termination of the a. ulnaris, which unites usually with the delicate ramus volaris superficialis of the a. radialis. It gives off small branches to the surrounding muscles and skin as well as three *aa. digitales volares communes* (O. T. palmar digital arteries), which extend distalward upon the 2nd—4th m. lumbricalis, receive the aa. metacarpeae volares II—IV (see also Fig. 511) and divide at the metacarpophalangeal joints, each into two *aa. digitales volares propriae* (O. T. collateral digital arteries) for the adjacent surfaces of the 2nd—5th finger.


Branch of the a. interossea volaris
Radius
Ulna
A. ulnaris
A. radialis
Ramus carpeus dorsalis a. ulnaris
Ramus carpeus volaris a. radialis
Ramus carpeus volaris a. ulnaris
Rete carpi volare
Ramus volaris superficialis a. radialis
M. abductor digiti V
Ramus volaris profundus a. ulnaris
M. opponens pollicis
M. flexor digiti V brevis
Arcus volaris profundus
Rami perforantes
A. metacarpea volaris I
Aa. metacarpeae volares II—IV
Aa. digitales volares communes
Aa. digitales volares propriae

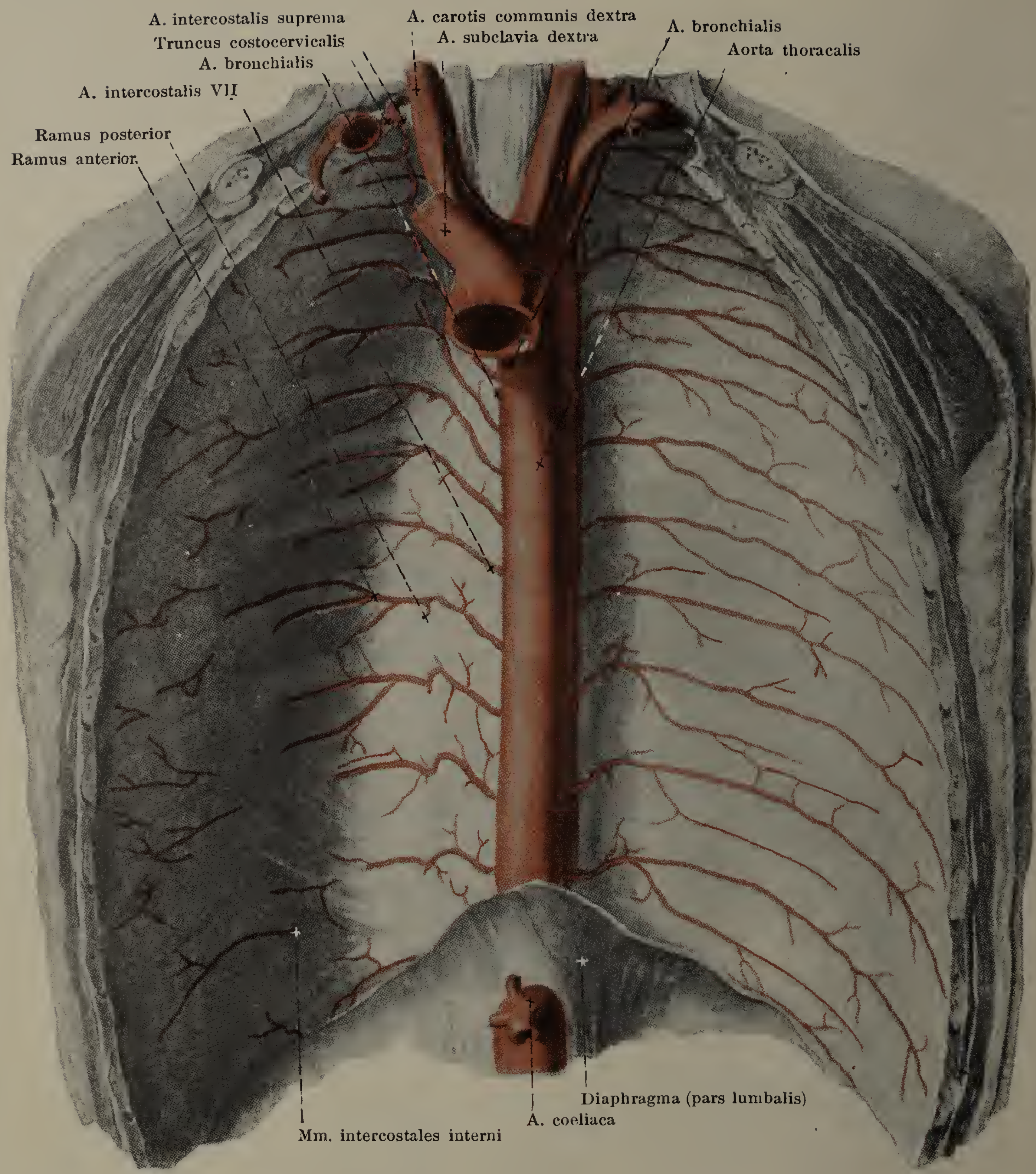
511. Arteries of the right palm, deep layer.

(All the structures have been removed with the exception of the mm. interossei, the muscles of the ball of the little finger and the insertions of the mm. opponens pollicis and flexor pollicis brevis.)

The *aa. digitales volares propriae* (see also Fig. 510) supply the volar surfaces and, from the region of the first joint of the finger on, also the dorsal surfaces of the fingers.

The **arcus volaris profundus** (O. T. deep palmar arch) lies directly upon the proximal ends of the ossa metacarpalia and the mm. interossei, covered by the tendons of all the flexors of the fingers and by the m. adductor pollicis. It forms a flatter curve than the superficial arch; its convexity looks distalward. In its formation is chiefly concerned the termination of the a. radialis, which anastomoses with the ramus volaris profundus of the a. ulnaris. Proximalward it gives off branches to the rete carpi volare, distalward four *aa. metacarpeae volares* (O. T. princeps pollicis, radialis indicis and palmar interosseous arteries) which run upon the mm. interossei. The first goes to the two margins of the thumb and to the radial margin of the index finger. The 2nd, 3rd and 4th artery gives off, close to its origin, a *ramus perforans*, which passes through the mm. interossei to the corresponding a. metacarpea dorsalis; the arteries finally anastomose, close to the heads of the ossa metacarpalia, with the aa. digitales volares communes.

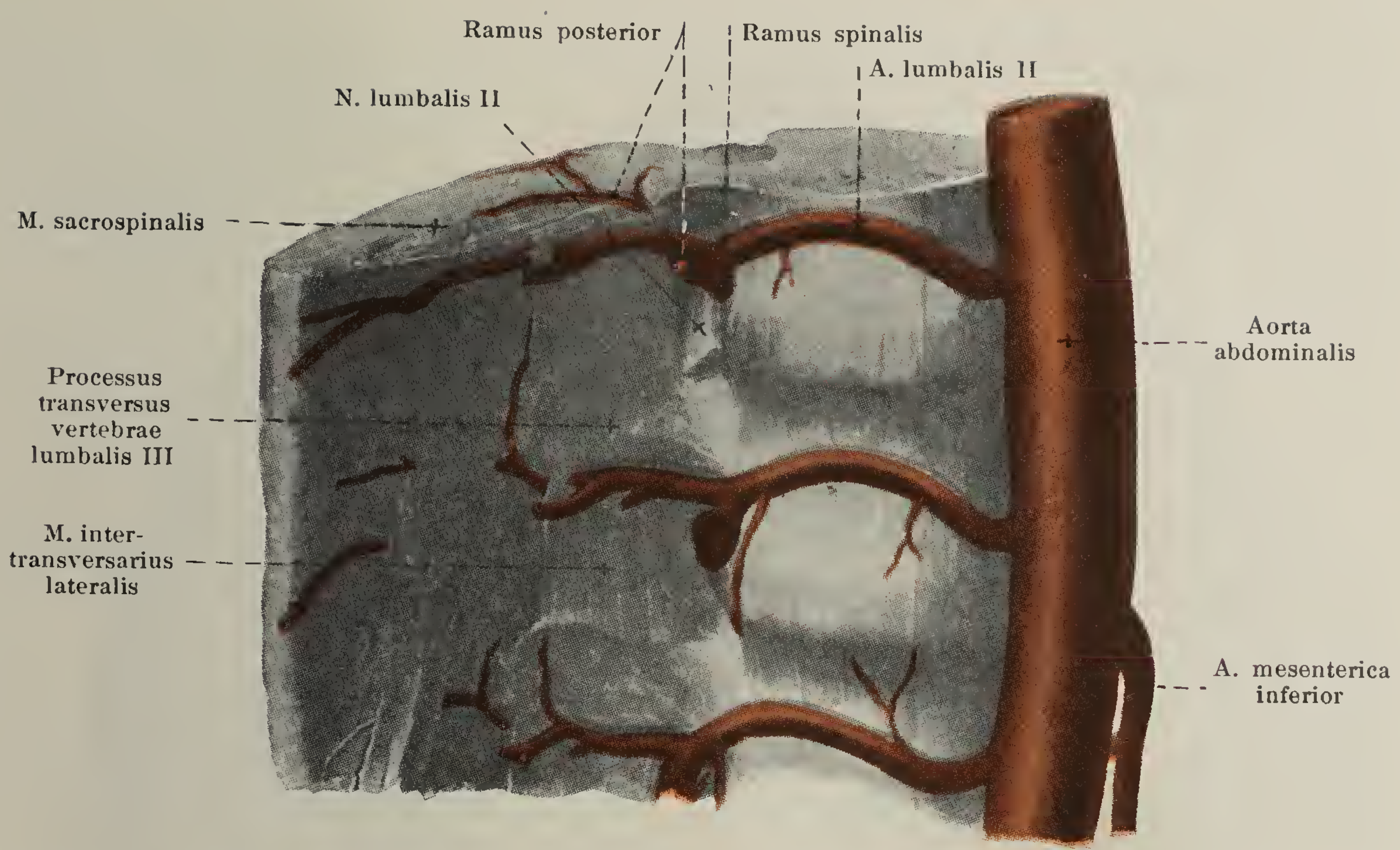
The **rete carpi volare** (O. T. anterior carpal rete) (see also Fig. 507) lies directly upon the volar surface of the wrist and consists of several fine branches from the a. interossea volaris, from the rami carpei volares of the aa. radialis and ulnaris and from the arcus volaris profundus.



512. Aorta thoracalis, viewed from in front.

(On the left side the mm. intercostales interni and subcostales have been removed; the diaphragm has been cut away at its origins. A part of the a. subclavia dextra has been cut off.)

The **aorta thoracalis** *(thoracic aorta)* (see also Figs. 607, 681—692) runs, from the left side of the body of the 4th thoracic vertebra on, downward and somewhat to the right and passes in front of the lower margin of the 12th thoracic vertebra, a little to the left of the median plane, through the hiatus aorticus of the diaphragm and there goes over into the aorta abdominalis. On the left side it is directly adjacent to the v. hemiazygos and is covered by the pleura mediastinalis (and is accordingly in direct contact with the cavum pleurae); on the right side it adjoins the ductus thoracicus and the v. azygos, above also the oesophagus, which further down lies on its anterior surface; in front it comes into relation also with the bronchus sinister and with the pericardium in the region of the left atrium. It gives off branches to the thoracic viscera, *rami viscerales,* and to the walls of the thorax, *rami parietales.*



513. Branches of the arteriae lumbales dextrae.

(A piece of the lumbar spine with its muscles, viewed from the right and somewhat from above.)

A. ***Rami viscerales:*** 1. **Aa. bronchiales** (see Fig. 512), 2—3, from the anterior wall of the first part of the vessel, very frequently (especially on the right side) from the a. intercostalis III. They go forward to the right and left bronchus and along with these into the lungs.

2. **Aa. oesophageae** (not illustrated), 3—7, from the anterior wall at different levels, forward and to the right to the oesophagus; the lowermost anastomoses with the a. gastrica sinistra.

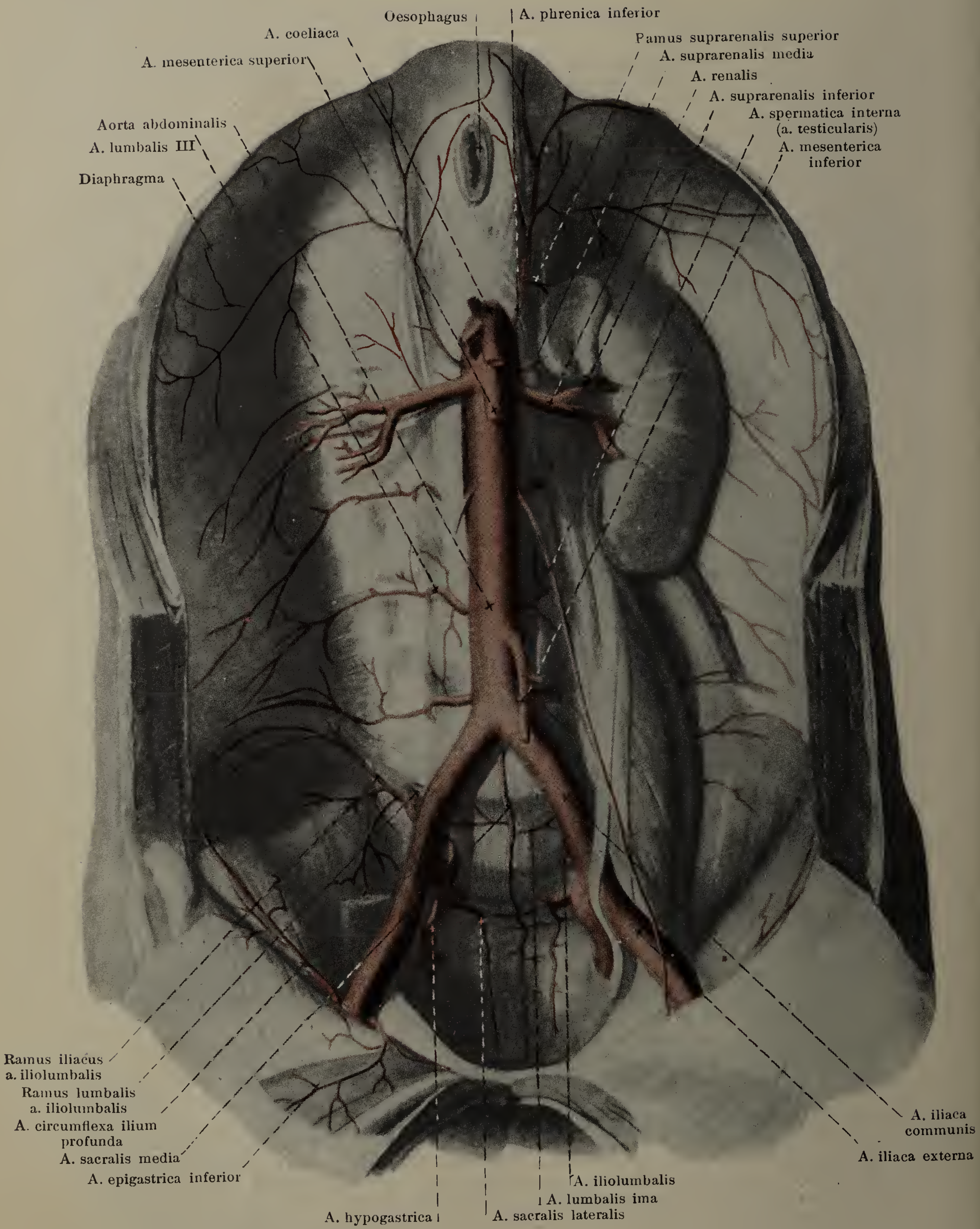
3. **Rami pericardiaci** (not illustrated), delicate, to the posterior wall of the pericardium.

4. **Rami mediastinales** (not illustrated), arising partly in common with the preceding, slender, going to the contents of the spatium mediastinale posterius; the lowermost spread out also upon the pars lumbalis of the diaphragm as the *aa. phrenicae superiores* (not illustrated).

B. ***Rami parietales:*** **Aa. intercostales** (see also Fig. 512), from the posterior wall, on each side (11) 10 for the (2nd) 3rd—11th intercostal space and the lower margin of the 12th rib. The upper arteries run upward in a recurrent direction, the lower more horizontally; the right are the longer. All of them lie upon the lig. longitudinale anterius, behind the truncus sympathicus and the v. azygos or hemiazygos, the right also behind the oesophagus and the ductus thoracicus. Each arrives at the lower margin of a capitulum costae and there divides.

a) *Ramus posterior* gives off a *ramus spinalis*, which goes through the foramen intervertebrale into the canalis vertebralis to the spinal cord and its surroundings. It then goes backward, medianward from the lig. costotransversarium anterius, gives off *rami musculares*, and divides into two branches. One of these runs between the mm. semispinalis and longissimus, appears in the vicinity of the median plane and turns lateralward to the skin *(ramus cutaneus medialis);* the other lies between the mm. longissimus and iliocostalis and goes often (especially in the lower segments) also to the skin *(ramus cutaneus lateralis).*

b) *Ramus anterior* runs forward in the spatium intercostale beneath the v. intercostalis internally of the mm. intercostales externi, at first covered only by the fascia endothoracica and the pleura, then between the mm. intercostales externi and interni, in the anterior half within the latter or at their inner side (see p. 285); it gives off a branch to the upper margin of the next lower rib and also many *rami musculares.* In front it anastomoses with the corresponding ramus intercostalis of the a. mammaria interna or of the a. musculophrenica. Besides the digitations of origin of the m. obliquus abdominis externus *rami cutanei laterales [pectorales et abdominales]* (not illustrated) go, some backward *(ramus posterior)* to the lateral, some forward *(ramus anterior)* to the anterior wall of the trunk; *rami mammarii laterales* go from the latter to the mammary gland. Only in the 4th—6th intercostal space, as a rule, small branches pass to the skin medial from the nipple *(rami cutanei anteriores [pectorales et abdominales])* (not illustrated) and some to the mammary gland *(rami mammarii mediales).*



514. Aorta abdominalis in the male, viewed from in front.

(On the right side the kidney and the mm. psoas and quadratus lumborum have been removed.)

The **aorta abdominalis** (see also Figs. 550 and 686) runs downward on the anterior surface of the lumbar vertebrae, a little to the left of the median plane. It is directly covered in front by the corpus pancreatis, the pars inferior duodeni and the peritonaeum, lies on the left side of the v. cava inferior and divides in front of the lower margin of the 4th lumbar vertebra into the *aa. iliacae communes dextra et sinistra.* Its branches are divisible into *rami parietales* (to the walls of the abdomen) and *rami viscerales* (to the abdominal viscera).

A. ***Rami parietales:***

1. **A. phrenica inferior,** paired, arises in front of the 12th thoracic vertebra, separated from, or in common with that of the other side, goes upward, forward and lateralward on the inferior surface of the pars lumbalis diaphragmatis (on the right side behind the foramen venae cavae) and helps to supply the diaphragm. Branches:

Rami suprarenales superiores, from the first part of the artery, to the adrenal.

2. **Aa. lumbales I—IV** (O. T. lumbar arteries) (see also Fig. 513), paired, go off, usually at a right angle, from the posterior wall, one in front of the body of each of the 1st—4th lumbar vertebra; they run backward on the lateral surface of the same, covered by the crura diaphragmatis and the origins of the m. psoas major, and pass through the m. quadratus lumborum to the muscles and to the skin of the lateral wall of the abdomen. Each gives off one branch:

Ramus posterior, corresponding exactly to the r. posterior of an a. intercostalis (see p. 437), gives off a *ramus spinalis* and goes to the muscles and skin of the lumbar region.

3. **A. sacralis media** (O. T. middle sacral artery) (see also Figs. 521 and 522), unpaired, from the posterior wall of the aorta a little above the bifurcation, extends downward, somewhat tortuous, in the median plane in front of the 5th lumbar vertebra, sacrum and coccyx. It gives off branches to the neighboring bones, muscles, nerves and to the rectum and ends in a vascular skein, the *glomus coccygeum* (not illustrated), situated beneath the tip of the coccyx. Branch:

A. lumbalis ima runs lateralward and downward, one on each side, upon the body of the 5th lumbar vertebra to the mm. psoas major and iliacus.

B. ***Rami viscerales:*** 3 paired and 3 unpaired; sometimes a branch to the ureter.

1. **A. suprarenalis media** (O. T. middle suprarenal artery), paired, arises a little below the a. coeliaca and runs directly in front of the crus mediale diaphragmatis to the adrenal.

2. **A. renalis** (O. T. renal artery) (see Fig. 550), paired, arises nearly at a right angle at the level of the 1st lumbar vertebra (or somewhat lower), runs transversely in front of the crus mediale diaphragmatis (on the right behind the v. cava inferior) behind the v. renalis and sends its branches in front of and behind the pelvis of the kidney to the substance of the kidney (see also Fig. 691). Variations in the origin and number are frequent. Each, by means of small branches to the tunica adiposa of the kidney, anastomoses with the aa. phrenica inferior, lumbales, suprarenales, spermatica interna and mesentericae. Each gives off also the *a. suprarenalis inferior* to the adrenal and two small branches to the ureter.

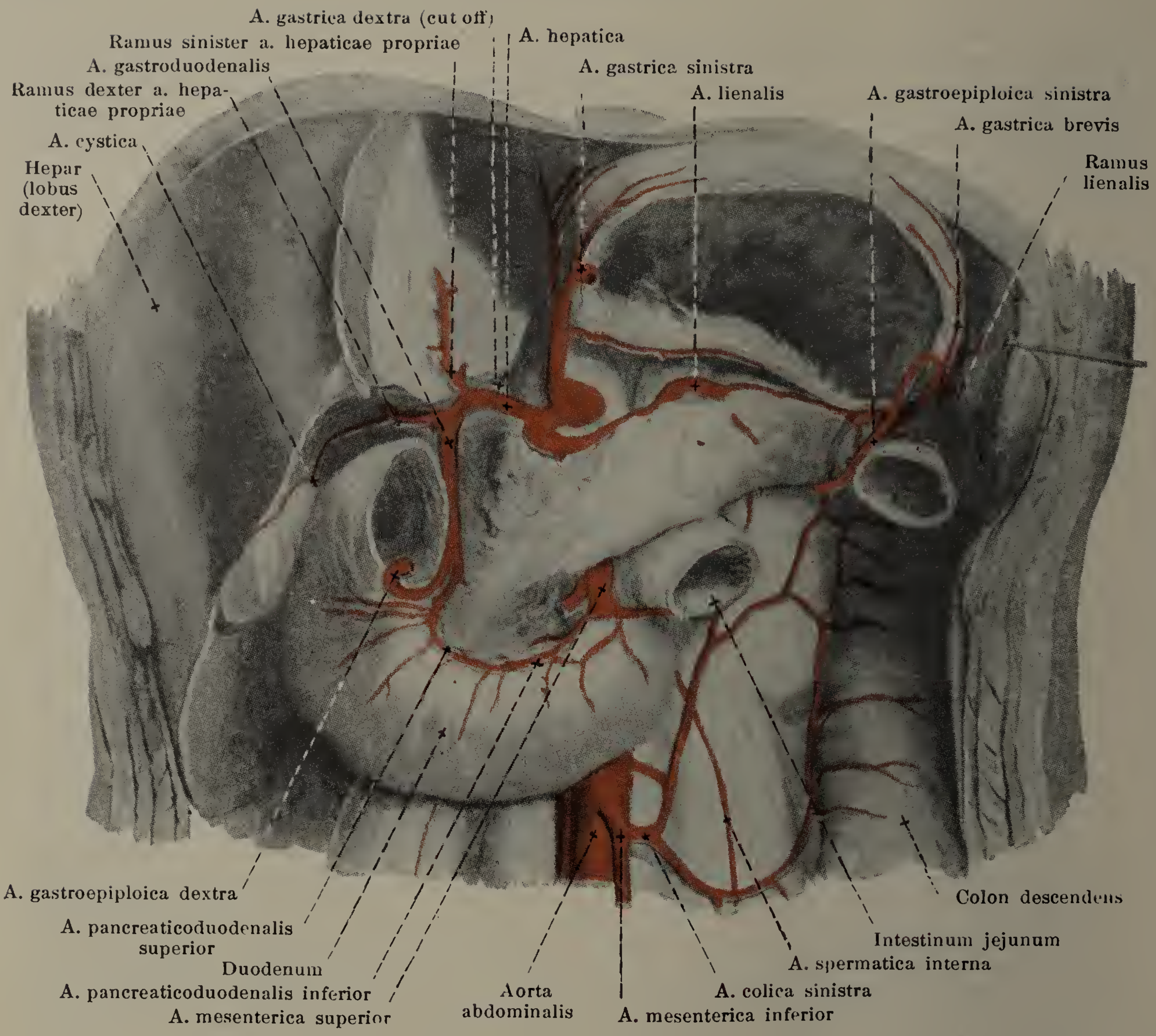
3. **A. spermatica interna** (O. T. spermatic artery) (see also Figs. 515, 516 and 550), paired, arises, at an acute angle, at the level of the 2nd lumbar vertebra, runs downward, lateralward and forward (on the right in front of the v. cava inferior) upon the mm. psoas major and minor, in front of the ureter, behind the peritonaeum, gives off branches to the tunica adiposa of the kidney, to lymph glands and seldom to the ureter and approaches the lateral margin of the pelvic inlet. Thence it is distributed differently in the two sexes. In the male, as the *a. testicularis* (see also Figs. 518, 521, 550 and 703), it goes upon the m. psoas major, in front of the a. and v. iliaca externa to the annulus inguinalis abdominalis and, surrounded by the plexus pampiniformis, in the spermatic cord to the epididymis and testicle; it anastomoses there with the a. deferentialis. In the female, as the *a. ovarica* (see Figs. 522, 523 and 554), it crosses the a. and v. iliaca externa, nearly in front of the ureter, enters into the lig. suspensorium ovarii, surrounded by the plexus pampiniformis, runs along the margo mesovaricus of the ovary, gives off branches to it and forms a broad anastomosis with the ramus ovarii of the a. uterina.

4. **A. coeliaca** (O. T. coeliac axis) (see also Figs. 515 and 549), unpaired, from the anterior wall between the 12th thoracic and the 1st lumbar vertebra, is short and divides at the upper margin of the corpus pancreatis into three branches:

a) *A. gastrica sinistra* (O. T. gastric or coronary artery) (see Figs. 515 and 516) bends forward and upward in the plica gastropancreatica to the right side of the cardia and runs in the omentum minus, along the curvatura minor of the stomach, to the right and downward. Small branches to the oesophagus *(rami oesophagei*, see p. 437), larger ones to the anterior and posterior wall of the stomach and to the omentum minus; all the arteries supplying the stomach freely anastomose with each other.

b) *A. hepatica* (O. T. hepatic artery) (see Figs. 515 and 516) runs upon the right crus mediale diaphragmatis at the upper margin of the pancreas behind and below the vestibulum bursae omentalis to the left, posterior surface of the pylorus. Branches:

ba) *A. gastrica dextra* (O. T. pyloric artery) arises at the pylorus and runs in the omentum minus along the curvatura minor to the left; it unites with the a. gastrica sinistra (see above) and gives off branches to the anterior and posterior wall of the stomach.



515. Arteries of the abdominal viscera,
deepest layer, viewed from in front.
(The left lobe of the liver, the largest part of the stomach, the small intestines and the colon transversum have been removed; the peritonaeum has been, in large extent, dissected off.)

4. **A. coeliaca** (continued):

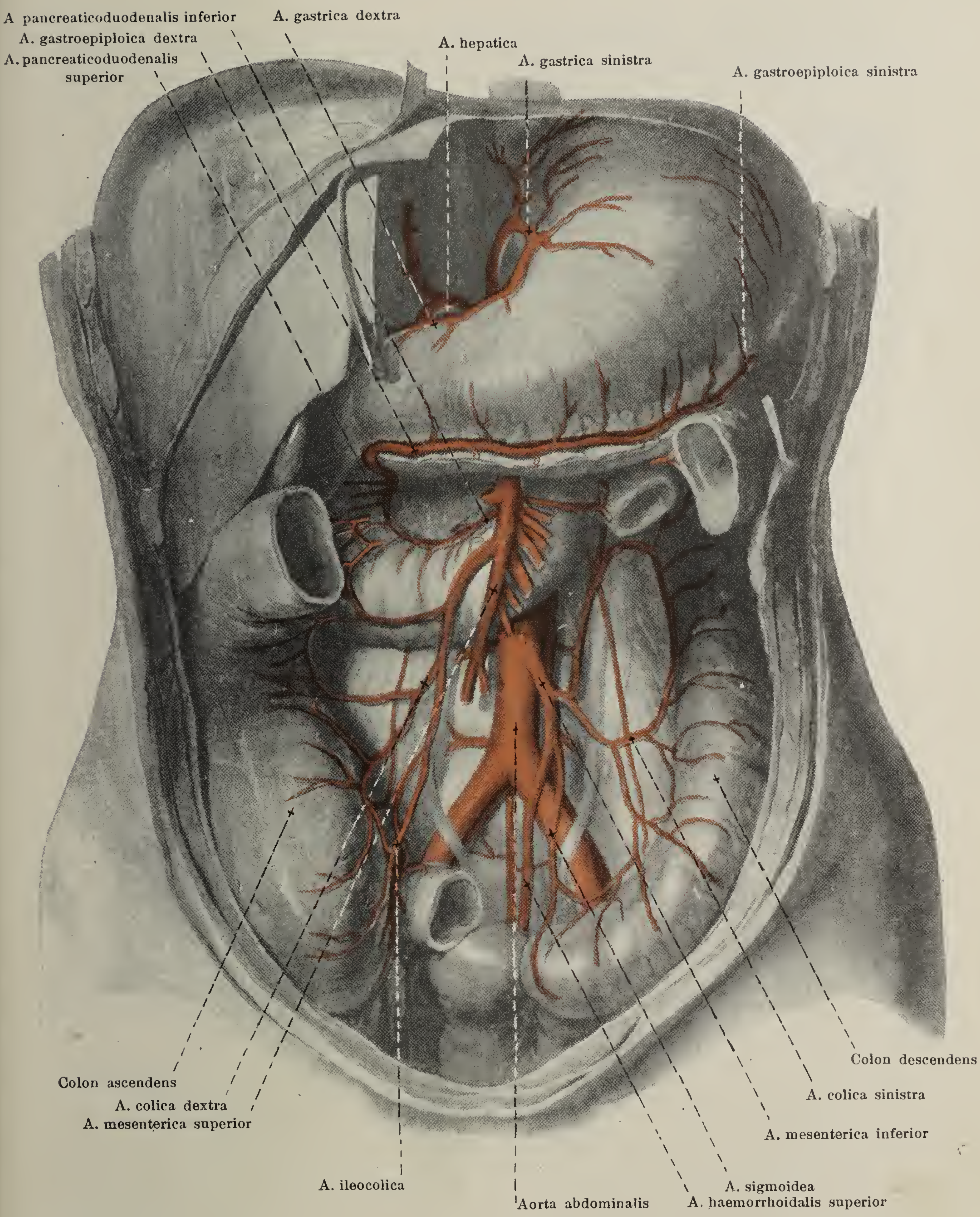
bb) *A. hepatica propria* ascends between the layers of the lig. hepatoduodenale, to the left of the ductus choledochus and in front of the v. portae (see Figs. 548 and 635), to the porta hepatis and there divides into a *ramus dexter* (O. T. right terminal branch) to the right half and a *ramus sinister* (O. T. left terminal branch) to the left half of the liver (see also Fig. 632). The former gives off the *a. cystica* to the gall bladder.

bc) *A. gastroduodenalis* (gastroduodenal artery) runs downward on the left and dorsal surface of the pars superior duodeni and divides into two branches:

α) *A. pancreaticoduodenalis superior* extends downward and to the left on the concave side of the pars descendens and pars inferior duodeni, between it and the caput pancreatis, unites with the a. pancreaticoduodenalis inferior and supplies, with its *rami pancreatici*, the caput pancreatis, and, with its *rami duodenales*, the duodenum.

β) *A. gastroepiploica dextra* (right gastroepiploic artery) (see Fig. 516) arrives at the lower surface of the pars superior duodeni between the two anterior layers of the omentum majus, runs to the left along the curvatura major of the stomach and unites with the a. gastroepiploica sinistra. Branches to the anterior and posterior wall of the stomach (see p. 439), as well as *rami epiploici* to the great omentum.

c) *A. lienalis* (O. T. splenic artery) (see Figs. 549, 637 and 638) bends to the left and extends to the left above the v. lienalis at the upper margin of the pancreas, as well as behind the bursa omentalis, in front of the left adrenal and kidney, in a tortuous course to the hilus of the spleen. Branches (see p. 442):



516. Arteries of the abdominal viscera,
more superficial layer, viewed from in front.

(The left lobe of the liver, the small intestines and the colon transversum have been removed; the mesenterium and mesocolon have been dissected off.)

4. **A. coeliaca** (continued):

ca) *Rami pancreatici*, numerous, to the corpus and to the cauda pancreatis.

cb) *A. gastroepiploica sinistra* (left gastroepiploic artery) (see also Fig. 516) runs forward in the lig. gastrolienale, goes to the right, between the two anterior layers of the omentum majus, along the curvatura major of the stomach, and unites with the a. gastroepiploica dextra; its branches are like those of the latter artery (see also p. 439).

cc) *Aa. gastricae breves* (see Fig. 515) in the lig. gastrolienale to the fundus ventriculi.

cd) *Rami lienales* from the hilus to the substance of the spleen (see Fig. 637).

5. **A. mesenterica superior** (superior mesenteric artery) (see also Figs. 514—516, 549 and 635), unpaired, arises just below the a. coeliaca, separated from it by the v. lienalis, in front of the 1st lumbar vertebra; it goes downward at first behind the caput pancreatis, then passes through the incisura pancreatis in the groove on the anterior surface of the processus uncinatus pancreatis and in front of the pars inferior duodeni between the layers of the mesenterium and runs in a curve, slightly convex to the left and forward, as far as the end of the small intestine.

a) *A. pancreaticoduodenalis inferior* (see Figs. 515 and 516) goes off from the right side, runs to the right on the concave surface of the pars inferior duodeni between it and the pancreas, supplies both organs and unites with the a. pancreaticoduodenalis superior.

b) *Aa. intestinales* (O. T. vasa intestini tenius), 12—20, from the convexity of the arch on the left side, pass between the layers of the mesenterium to the loops of the jejunum *(aa. jejunales)* and ileum *(aa. ileae)*. Each artery bifurcates and forms arch-like anastomoses with the branches of neighboring vessels; the branches arising from these form further anastomoses and so on until two to five series of anastomoses follow upon one another (see Fig. 547). From the last numerous branches of nearly equal size and almost equidistant from one another go to the small intestines. Small branches go also to the contents of the mesentery. The last a. ilea unites with the a. ileocolica.

c) *A. ileocolica*, from the right side, runs behind the peritonaeum to the right and downward to the end of the small and beginning of the large intestine, anastomoses with the last a. ilea and with the a. colica dextra. A small branch, the *a. appendicularis* (not indicated), goes behind the ileum to the vermiform process.

d) *A. colica dextra* (right colic artery), from the right side, very often a branch of the preceding artery, goes to the right behind the peritonaeum to the colon ascendens; it anastomoses with the a. ileocolica and with the a. colica media.

e) *A. colica media* (middle colic artery), from the right side, in front of the pancreas; it extends to the right and forward in the mesocolon transversum to the colon transversum; it anastomoses with the a. colica dextra and with the a. colica sinistra.

6. **A. mesenterica inferior** (see Figs. 513—516), unpaired, arises between the 3rd and 4th lumbar vertebra and runs downward and to the left, beneath the peritonaeum. Branches:

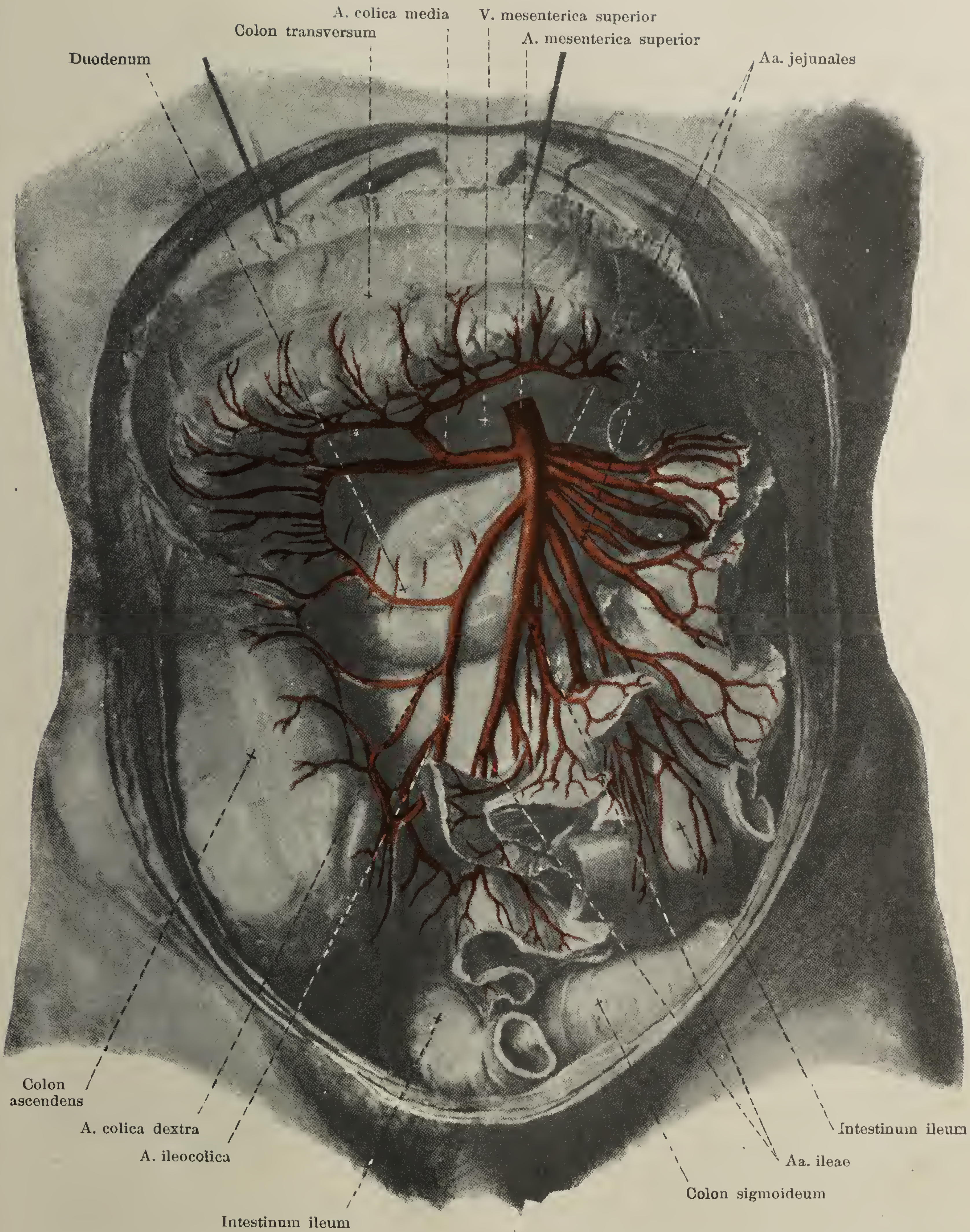
a) *A. colica sinistra* (left colic artery) beneath the peritonaeum to the left to the colon descendens; it anastomoses with the a. colica media and with the aa. sigmoideae.

b) *Aa. sigmoideae*, often single, run downward and to the left to the colon sigmoideum; they anastomose with the a. colica sinistra and with the a. haemorrhoidalis superior.

c) *A. haemorrhoidalis superior* (see also Figs. 516, 521 and 522), the terminal branch of the a. mesenterica inf., bends downward in front of the a. and v. iliaca communis sinistra and in front of the promontorium and goes downward in the mesorectum, in front of the sacrum and behind the rectum, and then divides into two branches which run right and left to the intestinum rectum; it anastomoses above with the aa. sigmoideae, below with the aa. haemorrhoidales mediae (from the aa. hypogastricae).

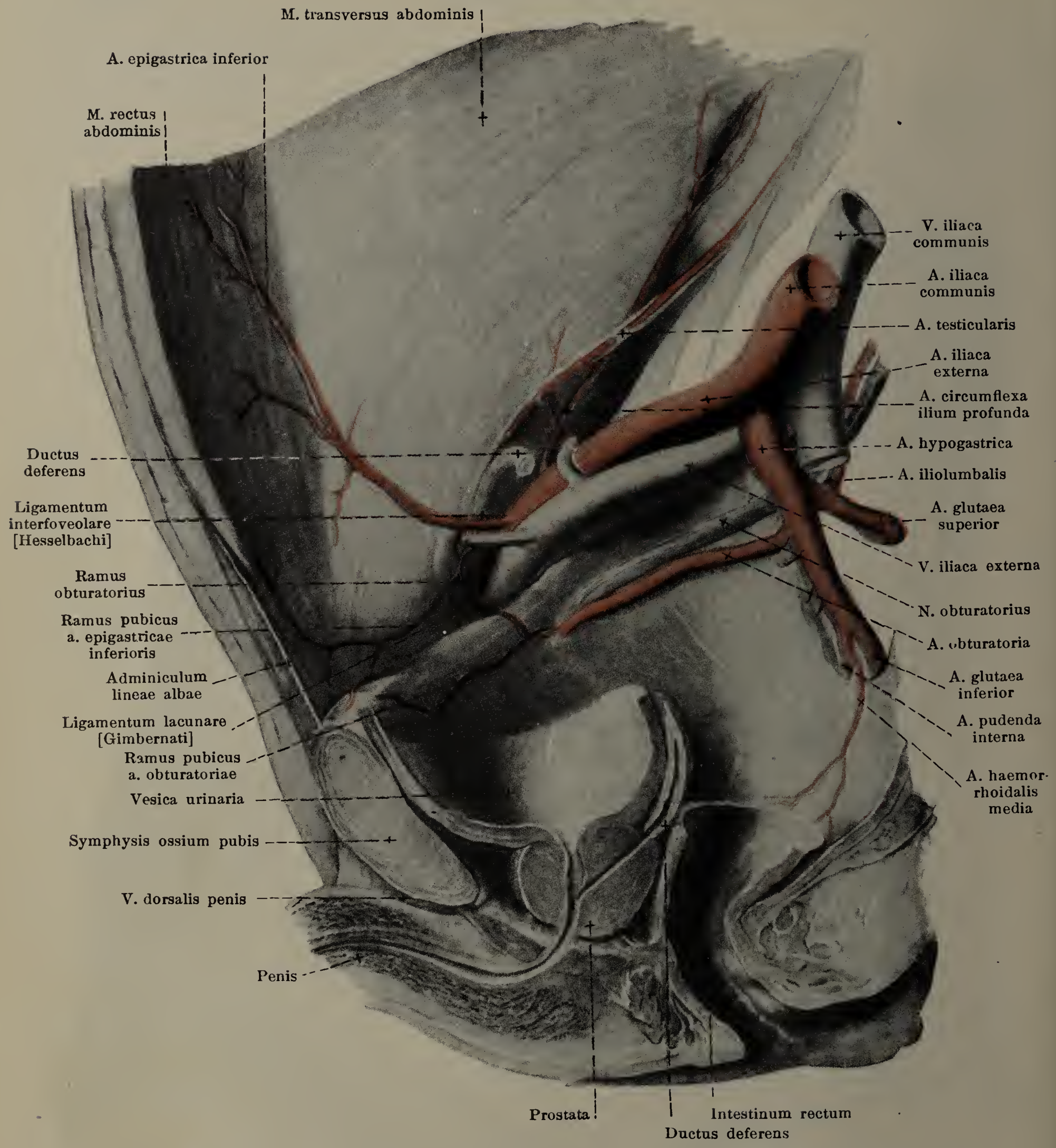
A. iliaca communis (iliac artery) (see also Figs. 514, 518, 519, 521, 522 and 550), paired, goes downward, lateralward and forward, slightly curved, in front of the bodies of the 4th and 5th lumbar vertebra at the medial margin of the m. psoas major; it runs on the left behind the a. haemorrhoidalis superior and, oftener on the left, behind the ureter. It lies in front of and somewhat to the left of the v. iliaca communis. It divides in front of the articulatio sacroiliaca into the *a. hypogastrica* and the *a. iliaca externa;* a small branch to the ureter.

A. hypogastrica (see Figs. 514, 518, 519, 521, 522 and 551) turns downward and somewhat backward into the small pelvis and divides, after a short course, usually into a posterior and an anterior branch. The posterior branch bends markedly backward to the upper part of the foramen ischiadicum majus (above the m. piriformis), gives off the *aa. iliolumbalis* and *sacralis lateralis* and ends as the *a. glutaea superior.* The anterior branch runs in front of the m. piriformis to the inferior portion of the foramen ischiadicum majus, gives off the *aa. umbilicalis* (or *aa. vesicales superiores), obturatoria, vesicalis inferior, deferentialis* (in the male), *uterina* (in the female) and *haemorrhoidalis media* and bifurcates into the *aa. glutaea inferior* and *pudenda interna.* The subdivisions of the posterior branch (also the a. obturatoria and the a. glutaea inferior) go chiefly to the walls of the pelvis as *rami parietales,* those of the anterior branch (with the exception of the a. obturatoria and the a. glutaea inferior) chiefly to the viscera as *rami viscerales.* In addition to these a small branch to the ureter.



517. Branches of the a. mesenterica superior,
viewed from in front.

(The small intestine has been cut away at the mesentery with the exception of two loops, the transverse colon has been drawn upward, the great omentum cut off, and the mesentery reflected to the left. The mesentery and mesocolon have been partially dissected away.)



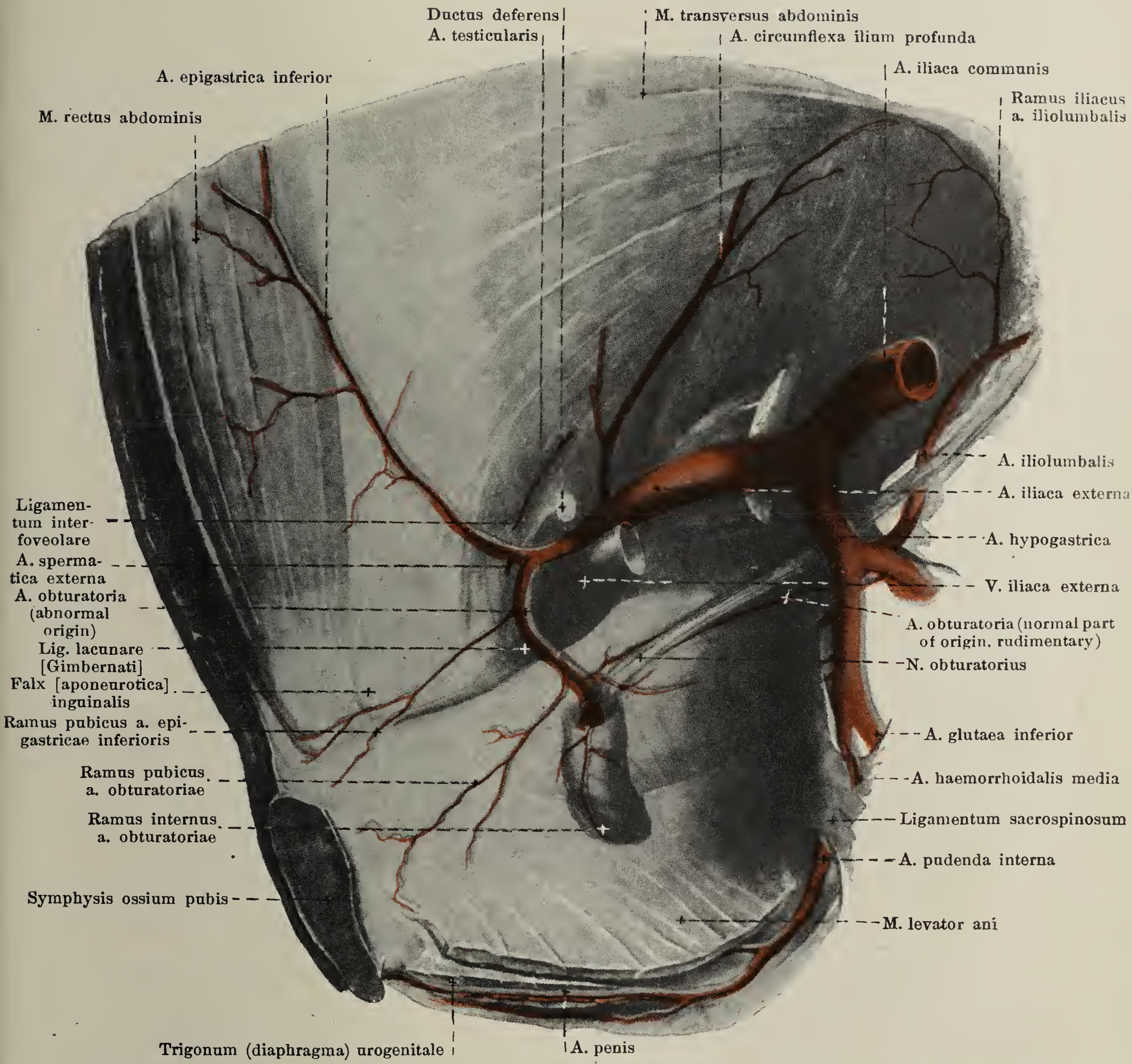
518. Right a. obturatoria and a. epigastrica inferior, in the male, viewed from the left.

A. ***Rami parietales:***

1. **A. iliolumbalis** (O. T. iliolumbar artery) (see also Figs. 514 and 519) turns lateralward and upward behind the n. obturatorius, between the basis ossis sacri and the m. psoas major and divides into two branches:

a) *Ramus lumbalis* corresponds to the ramus posterior of an a. lumbalis (see Fig. 513), runs dorsally between the proc. transversus of the 5th lumbar vertebra and the basis of the sacrum and gives off a *ramus spinalis* to the spinal canal; it supplies the neighboring muscles and skin.

b) *Ramus iliacus* runs behind the m. psoas major along the crista iliaca, gives off branches to the bones and muscles; it unites with the a. circumflexa ilium profunda.


Ductus deferens
A. testicularis
M. transversus abdominis
A. circumflexa ilium profunda
A. iliaca communis
Ramus iliacus a. iliolumbalis
A. epigastrica inferior
M. rectus abdominis
A. iliolumbalis
A. iliaca externa
A. hypogastrica
V. iliaca externa
A. obturatoria (normal part of origin. rudimentary)
N. obturatorius
A. glutaea inferior
A. haemorrhoidalis media
Ligamentum sacrospinosum
A. pudenda interna
M. levator ani
Ligamentum interfoveolare
A. spermatica externa
A. obturatoria (abnormal origin)
Lig. lacunare [Gimbernati]
Falx [aponeurotica] inguinalis
Ramus pubicus a. epigastricae inferioris
Ramus pubicus a. obturatoriae
Ramus internus a. obturatoriae
Symphysis ossium pubis
Trigonum (diaphragma) urogenitale
A. penis

519. Abnormal a. obturatoria dextra in the male *(Var.)*

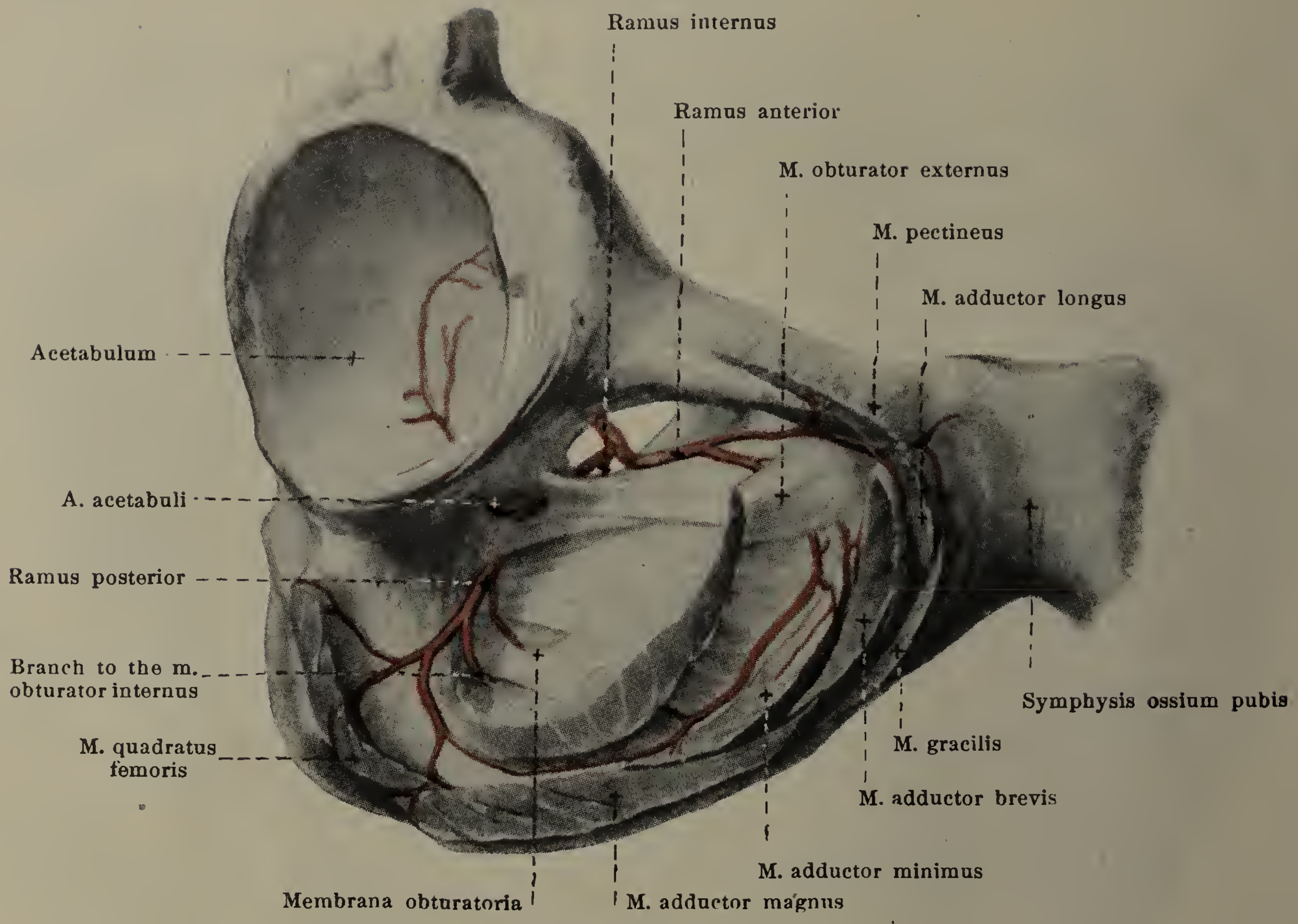
(A window has been cut out of the mm. obturator internus and levator ani.)

2. **A. sacralis lateralis** (lateral sacral artery) (see Figs. 514 and 521) downward, single or double, medially from the foramina sacralia, upon the fascia pelvina of the sacrum, gives off *rami spinales* through the foramina sacralia anteriora into the canalis sacralis, and branches to the muscles and to the skin of the back.

3. **A. obturatoria** (obturator artery) (see Figs. 518, 520—522 and 527), frequently from the posterior branch, extends, covered by peritonaeum, forward and downward beneath the linea terminalis pelvis and beneath the n. obturatorius to the canalis obturatorius, inside which it divides into its terminal branches. In the pelvis, small branches to its surroundings, as well as:

a) *Ramus pubicus.* This runs medianward on the posterior surface of the ramus superior ossis pubis and anastomoses on the upper surface of the lig. lacunare [Gimbernati] (see Fig. 525) or laterally from it with the ramus obturatorius of the a. epigastrica inferior. By this anastomosis the a. obturatoria arises in about one third of the cases from the a. epigastrica, it lies more often laterally from the annulus femoralis, more rarely on the septum femorale or on the lig. lacunare.

b) *Ramus internus*, medial from the membrana obturatoria, downward to the ischium.



520. Terminal branches of the a. obturatoria dextra (male pelvis), viewed from in front and from the right.

(The muscles of the thigh have been cut off short at their origin.)

3. **A. obturatoria** (continued): Terminal branches:

c) *Ramus posterior* goes downward in the membrana obturatoria to the anterior surface of the ramus superior ossis ischii, and gives off, as it goes, the *a. acetabuli*, which passes through the incisura acetabuli to the hip-joint and through the lig. teres to the caput femoris; it also gives off branches which pass through the membrane to the m. obturator internus, and sends its terminal branches in part forward upon the origin of the m. obturator externus, in part backward, especially to the ischium.

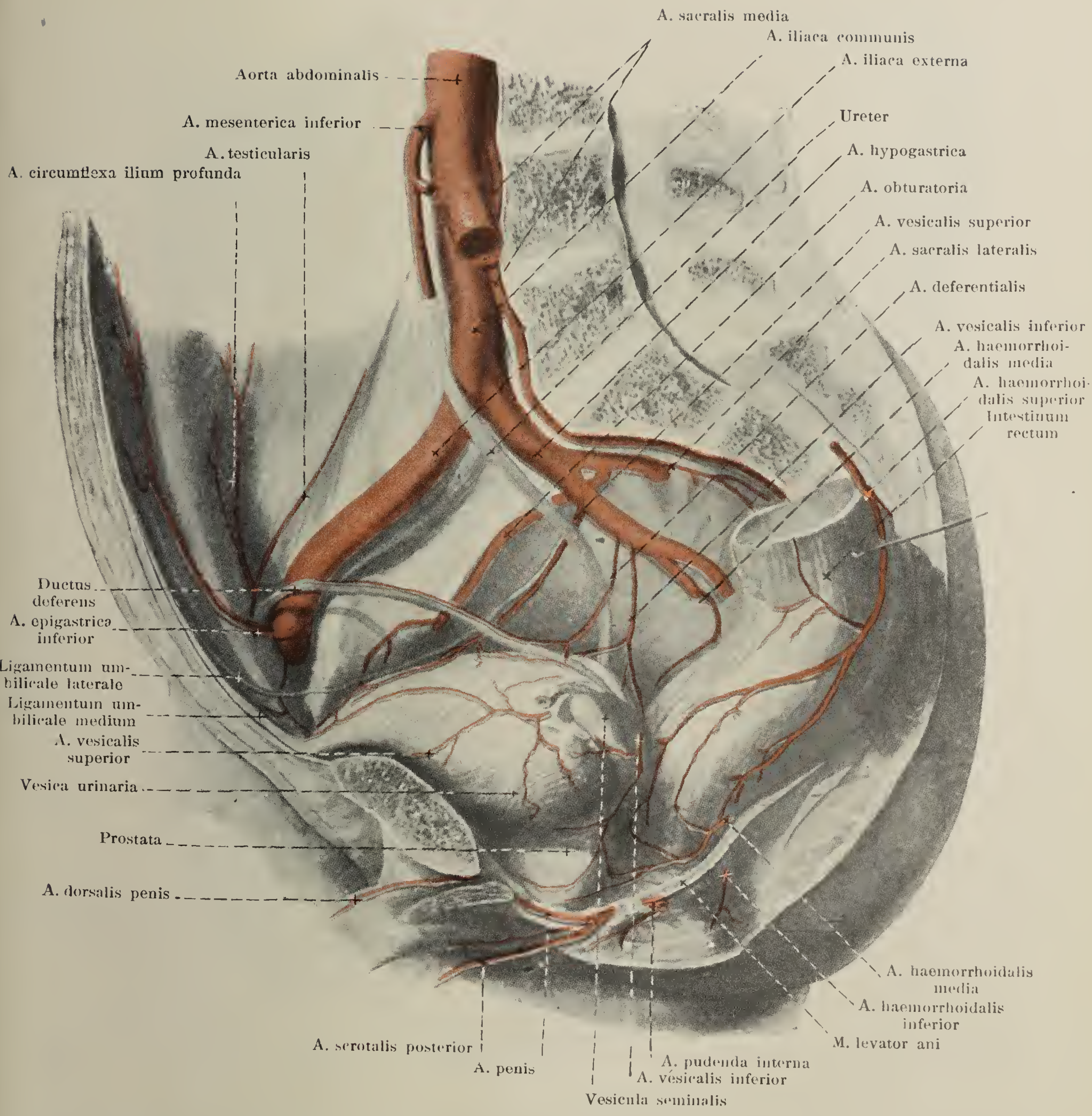
d) *Ramus anterior* forward upon the external surface of the membrane and then, partly through, partly in front of the m. obturator externus, toward the preceding artery.

4. **A. glutaea superior** (gluteal artery) (see Figs. 518, 521 and 528), between L_5 and S_1 backward through the foramen suprapiriforme, gives small branches to the surrounding muscles and bones and divides into a superficial branch, which goes lateralward and downward between the mm. glutaeus maximus and medius, and into a deep branch, which runs lateralward between the mm. glutaeus medius and minimus. This latter branch divides into a *ramus superior* along the upper margin of the m. glutaeus minimus and into a *ramus inferior* lower down, on the m. glutaeus minimus. It gives off, also, branches to the skin of the region.

5. **A. glutaea inferior** (see Figs. 518, 521 and 528) runs between S_2 and S_3 or S_3 and S_4 through the foramen infrapiriforme, between the lower margin of the m. piriformis and the lig. sacrospinosum backward and downward to the anterior surface of the m. glutaeus maximus. It supplies especially this muscle, its neighbors and the skin covering that region and gives off a fine *a. comitans n. ischiadici* which goes downward to the n. ischiadicus.

B. ***Rami viscerales.***

1. **A. umbilicalis** (O. T. hypogastric artery) (see Figs. 521, 522, 561 and 562), present in its full development only before birth, runs in a curve, on the inner wall of the small pelvis, forward and upward to the anterior abdominal wall, arrives on this behind the lateral margin of the tendon of the m. rectus abdominis and then goes, beneath the peritonaeum in the plica umbilicalis lateralis, to the navel (see also Figs. 379 and 650). It gives off the *aa. vesicales superiores* to the upper part of the bladder; from these go small branches to the ureter. After birth only the beginning of the artery and the branches to the bladder remain open, the largest part of the vessel becomes obliterated to form the *ligamentum umbilicale laterale* (O. T. lateral false ligament) (see Fig. 650).



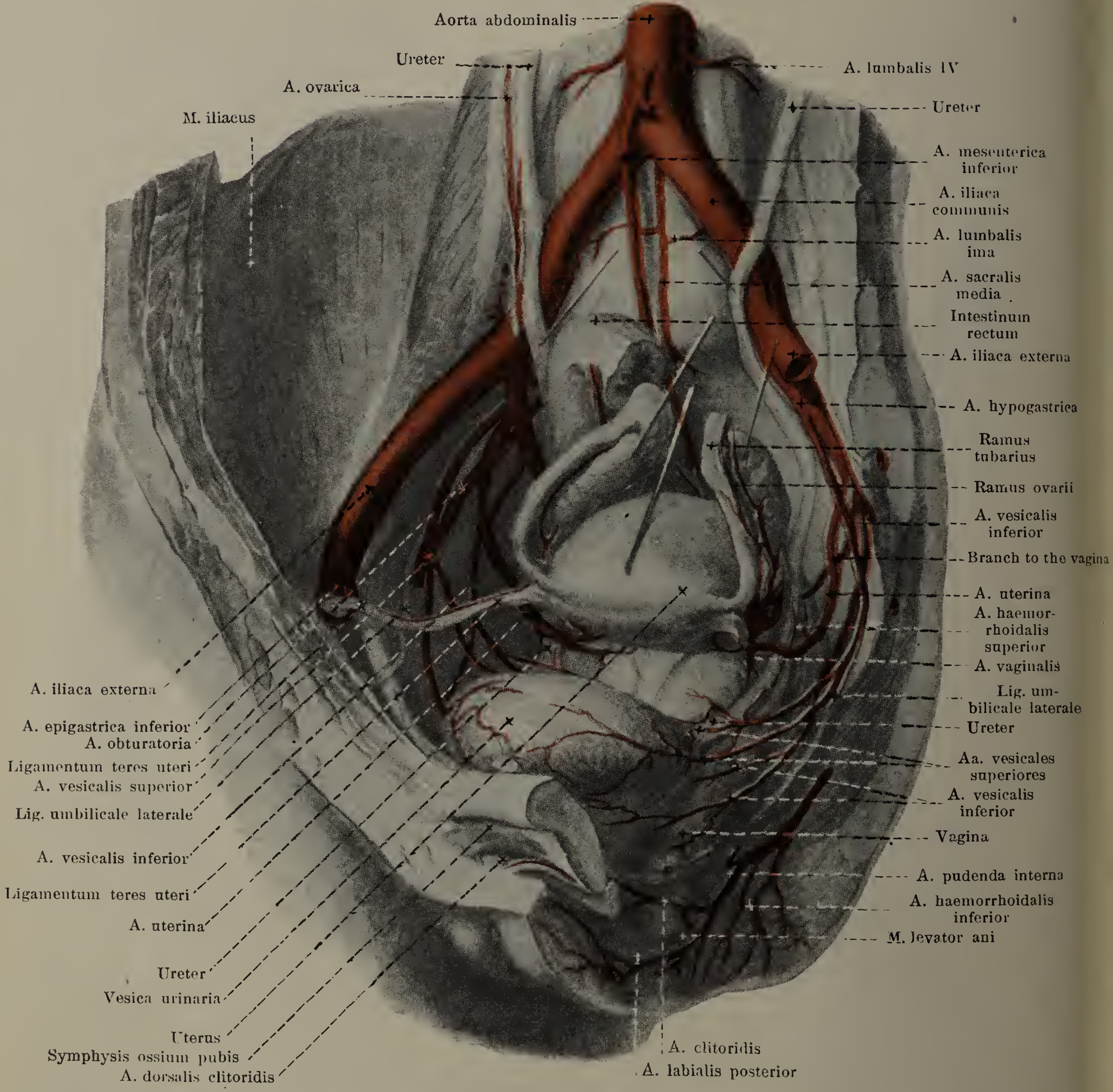
521. Arteries of the male pelvis, viewed from the left.

(The rectum has been drawn somewhat to the left, the peritonaeum has been removed.)

2. **A. deferentialis** (O. T. artery of the vas deferens) (present only in the male), frequently arising from the preceding artery or from the following, passes forward and downward to the ductus deferens, there divides, one part going downward as far as the vesicula seminalis, the other upward to the inguinal canal and thence to the epididymis; it anastomoses there with the a. testicularis.

3. **A. vesicalis inferior** (see also Figs. 522 and 523) goes downward to the fundus vesicae, in the male also to the vesicula seminalis and the prostata, in the female to the vagina.

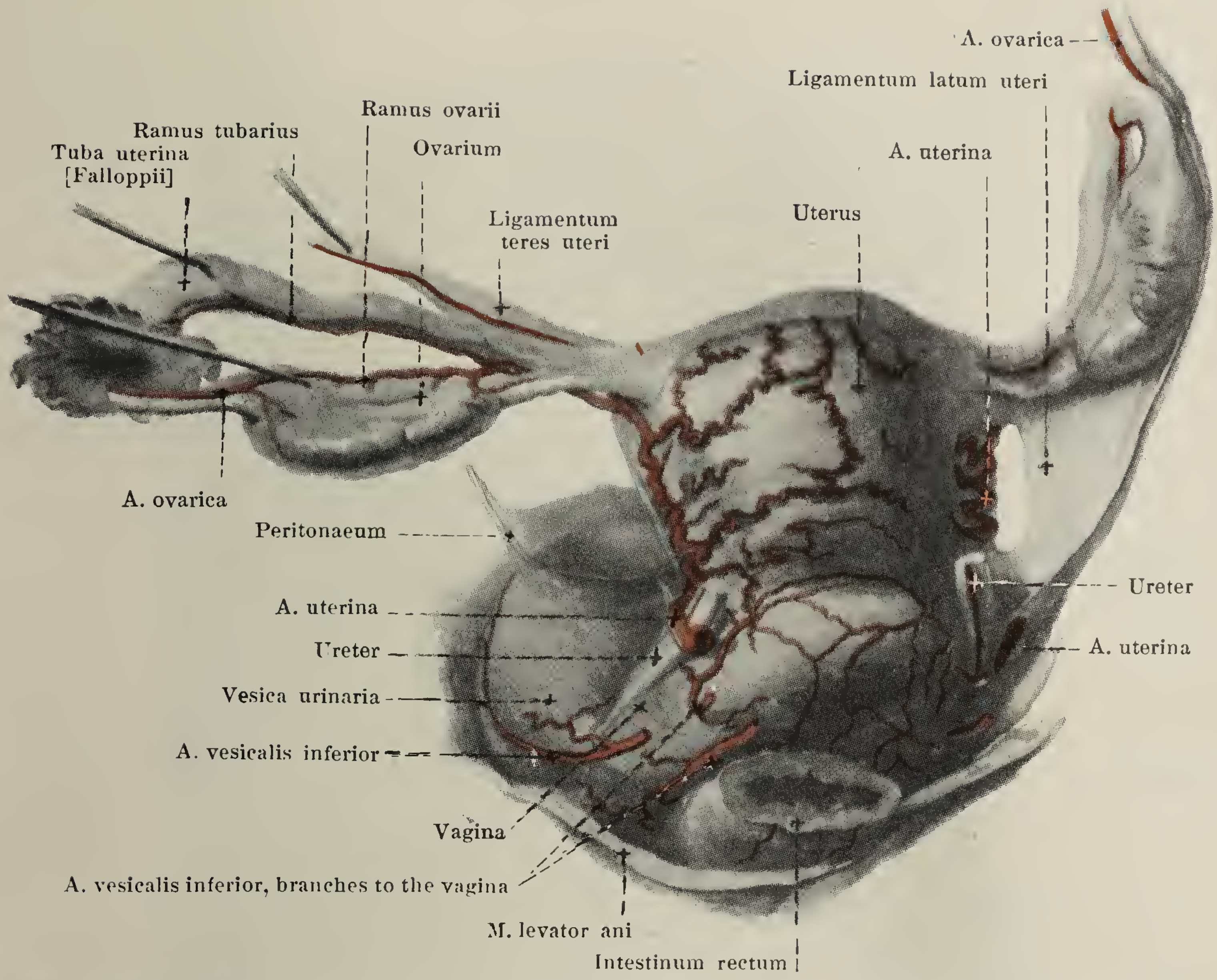
4. **A. haemorrhoidalis media** (middle haemorrhoidal artery) (not constant) (see also Fig. 518) comes frequently from the a. pudenda interna and runs over the m. coccygeus and m. levator ani, downward and medianward to the rectum and to the surrounding muscles; it gives off branches to the vesiculae seminales and to the prostata in the male, to the vagina in the female. It anastomoses also with the aa. haemorrhoidales superior and inferior.



522. Arteries of the female pelvis, viewed somewhat from the left.

(The organs have been partly drawn out of their position; the peritonaeum has been removed.)

5. **A. uterina** (uterine artery) (present only in the female) (see also Fig. 523) goes forward beneath the peritonaeum at first on the inner wall of the small pelvis, then turns medianward, runs through the parametrium obliquely forward in front of the ureter to the cervix uteri and there gives off a small branch to the ureter as well as the *a. vaginalis*, which runs downward on the lateral wall of the vagina. The uterine artery then runs along the margo lateralis uteri, following a very tortuous course between the layers of the ligamentum latum uteri, as far as the fundus uteri and sends off numerous corkscrew-like, tortuous branches to the anterior and posterior surface of the uterus, anastomosing with one another and with those of the other side; it ends in a branch which runs in the ligamentum latum partly to the ligamentum teres uteri and to the tuba uterina *(ramus tubarius,* anastomosis with a. ovarica), partly to the ovary *(ramus ovarii);* the latter branch runs along the margo mesovaricus of the ovary and forms a broad anastomosis with the a. ovarica.



523. Arteries of the uterus and surrounding structures, viewed from behind and somewhat from the left. (On the left side the ovary, the Fallopian tube and the ligamentum teres uteri have been displaced from their normal position.)

6. **A. pudenda interna** (see Figs. 519, 524 and 525) goes downward at the lower margin of the m. piriformis behind the lig. sacrospinosum, encompasses the spina ischiadica and passes forward, in the form of a curve, along the medial surface of the ramus superior, then along that of the ramus inferior ossis ischii; in its course it runs somewhat (about the width of the little finger) above the processus falciformis and is covered by the fascia obturatoria; close behind the m. transversus perinei superficialis it divides into the *a. perinei* and the *a. penis* (or *a. clitoridis).* It frequently gives off above the lig. sacrospinosum small branches to the surrounding muscles and nerves, and often, also, the a. haemorrhoidalis media. Other branches:

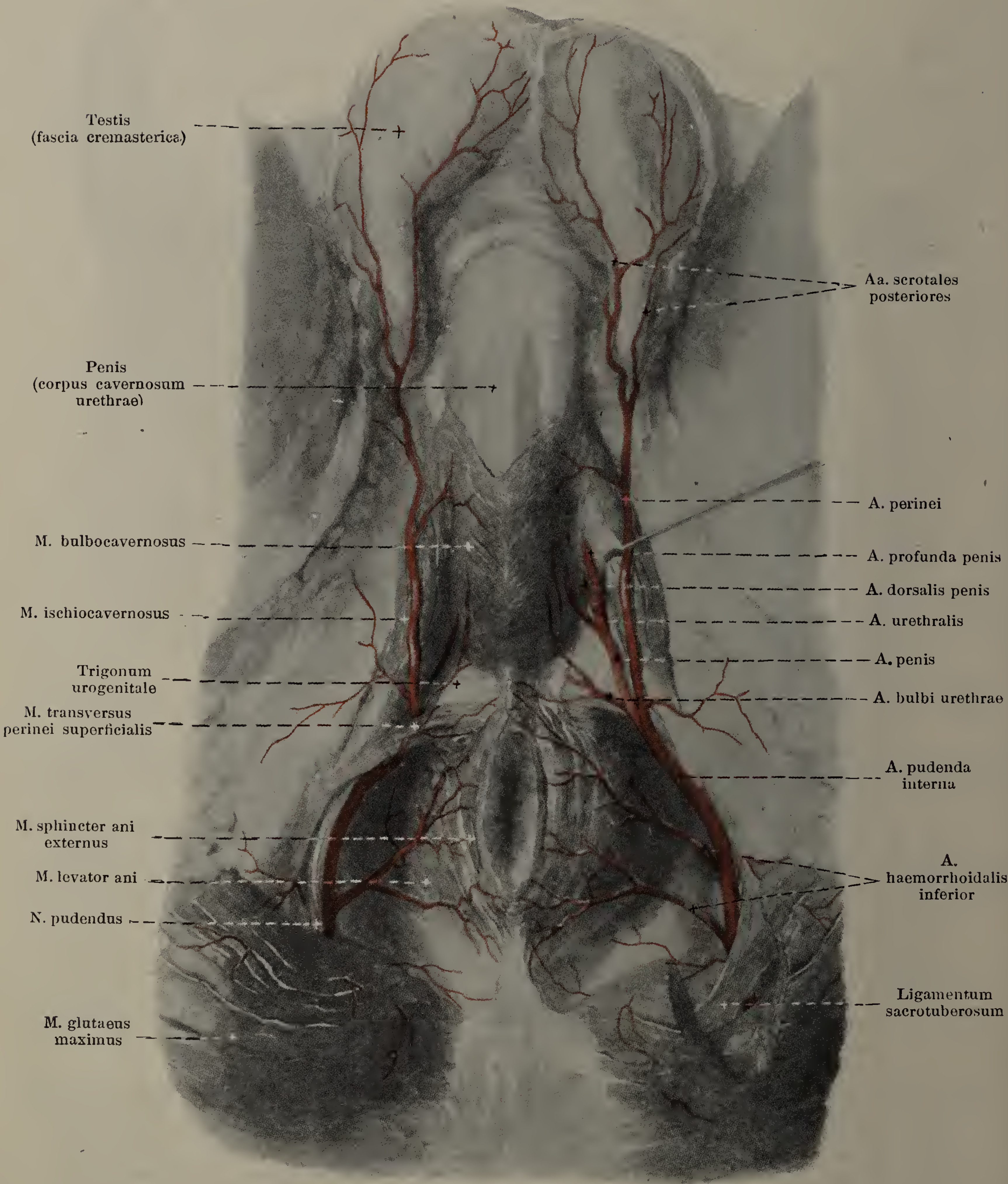
a) *A. haemorrhoidalis inferior* (O.T. external or inferior haemorrhoidal artery) (see Figs. 524 and 525), usually double or triple. It runs, transversely medianward through the fat of the fossa ischiorectalis, being fairly superficial, to the fat, muscles and skin about the anus. It anastomoses wiht the aa. haemorrhoidalis media and sacralis media.

b) *A. perinei* (O. T. superficial perineal artery) (see Figs. 524 and 525) extends, over or under the m. transversus perinei superficialis, forward and medianward; it is superficial, being covered only by the fascia superficialis perinei; it goes in the male to the posterior surface and to the septum of the scrotum by means of the *aa. scrotales posteriores,* in the female into the labium majus and labium minus by means of the *aa. labiales posteriores.* It also gives off small branches to the superficial muscles of the perineum.

ca) *A. penis* (in the male only) (see Figs. 519, 524, 711, 726 and 730) runs forward, in the direction of the main stem, close to the ramus inferior ossis pubis, within the trigonum urogenitale, leaves it behind the lig. transversum pelvis, passes in front of and below the latter until it lies below the lig. arcuatum pubis where it is continued directly into the a. dorsalis penis. Branches:

  α) *A. bulbi urethrae* (O. T. artery of the bulb) (see Fig. 524) goes off at the posterior margin of the trigonum urogenitale and runs medianward and forward to the bulbus urethrae and to the neighboring muscles.

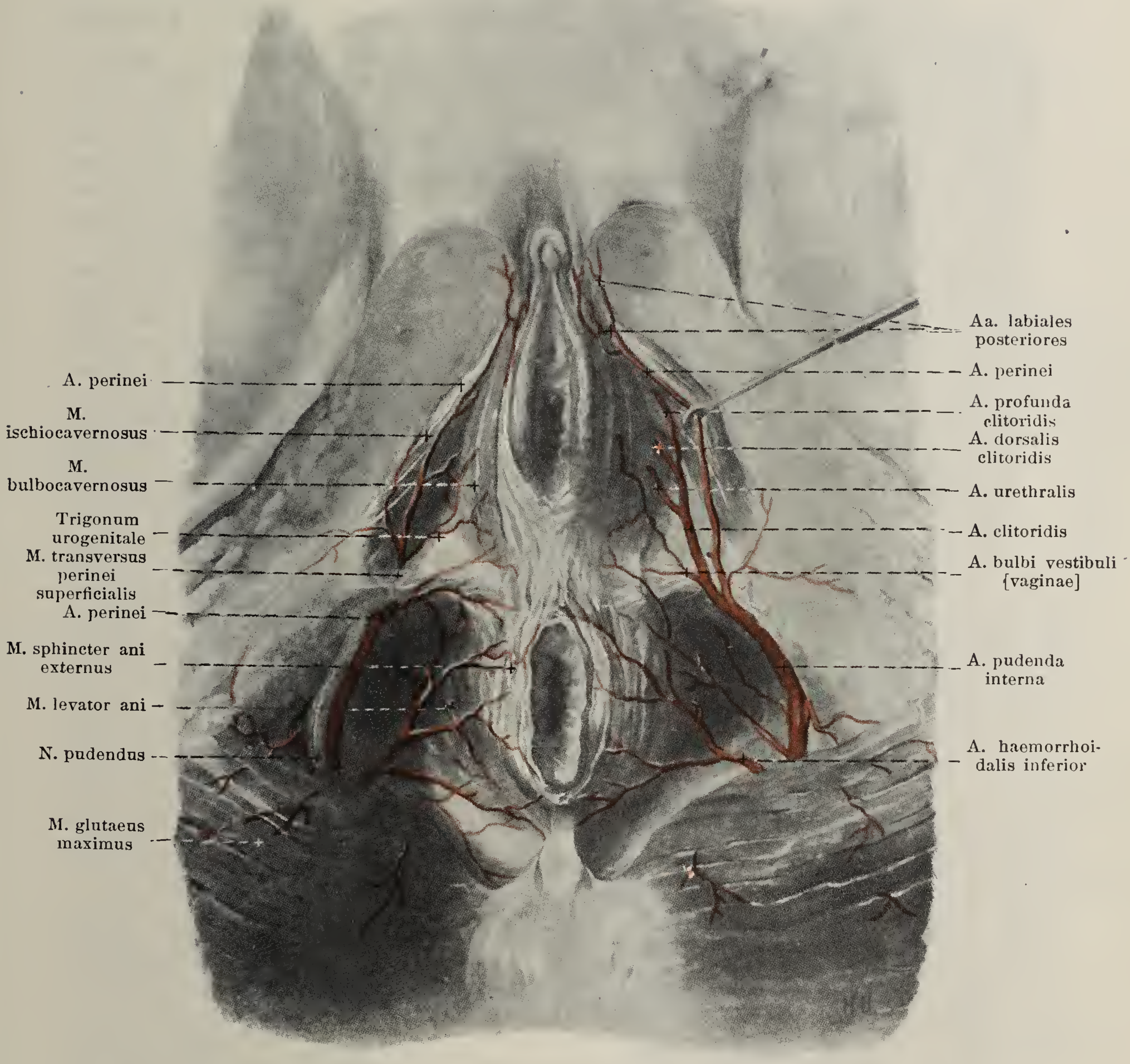
  β) *A. urethralis* (s. Fig. 524), forward and medianward to the corpus cavernosum urethrae.



524. Arteries of the male perineum.

(On the left side the dissection shows the m. transversus perinei profundus; the crus penis has been drawn aside.)

γ) *A. profunda penis* arises close under the ligamentum arcuatum pubis, penetrates the crus penis on its medial surface and runs in it partly backward, partly forward close to the septum penis (see also Fig. 712) as far as its tip; its branches anastomose with one another and with those of the opposite side.



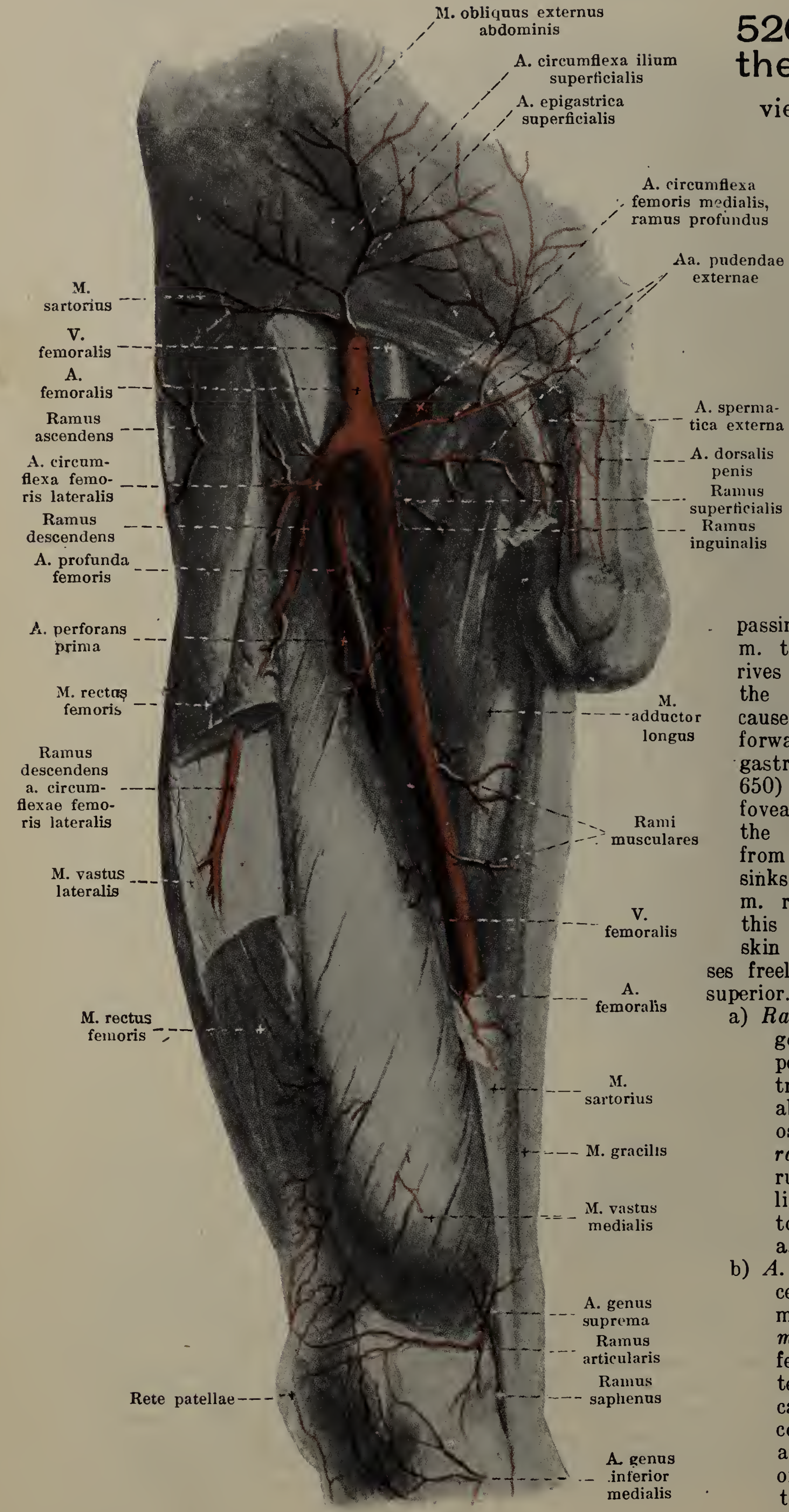
525. Arteries of the female perineum.

(Dissection similar that of Fig. 524; the crus clitoridis has been drawn aside.)

δ) *A. dorsalis penis* (see Figs. 521, 524, 526 and 712) goes near the lig. suspensorium penis to the dorsum penis and in its medial groove, on each side near the unpaired v. dorsalis penis, as far as the glans; it gives branches to the skin, to the corpora cavernosa penis et urethrae and especially to the glans penis.

cb) *A. clitoridis* (present only in the female) is comparable in its course to the a. penis; it gives off the *a. bulbi vestibuli [vaginae]* to the perineal muscles, the vagina and the bulbus vestibuli, the *a. urethralis* to the latter and to the vestibulum vaginae, and the *a. profunda clitoridis* to the crus clitoridis; the *a. dorsalis clitoridis* runs upon the clitoris to the glans clitoridis, praeputium clitoridis and labia minora.

A. iliaca externa (external iliac artery) (see Figs. 514, 518, 519, 521, 522, 527, 550, 551 and 554) goes downward, lateralward and forward on the medial, anterior surface of the m. psoas major; it runs at first to the lateral side of the v. iliaca externa, in front of the fascia iliaca and behind the peritonaeum; on the right side oftener than on the left the anterior and medial surface of its initial portion is crossed by the ureter. It goes through the lacuna vasorum beneath the lig. inguinale (see Fig. 421) and from there on is called the *a. femoralis.* Branches:



526. Arteries of the right thigh,

viewed from in front, superficial layer.

(The m. sartorius has been for the most part removed and a piece has been cut out of the m. rectus femoris.)

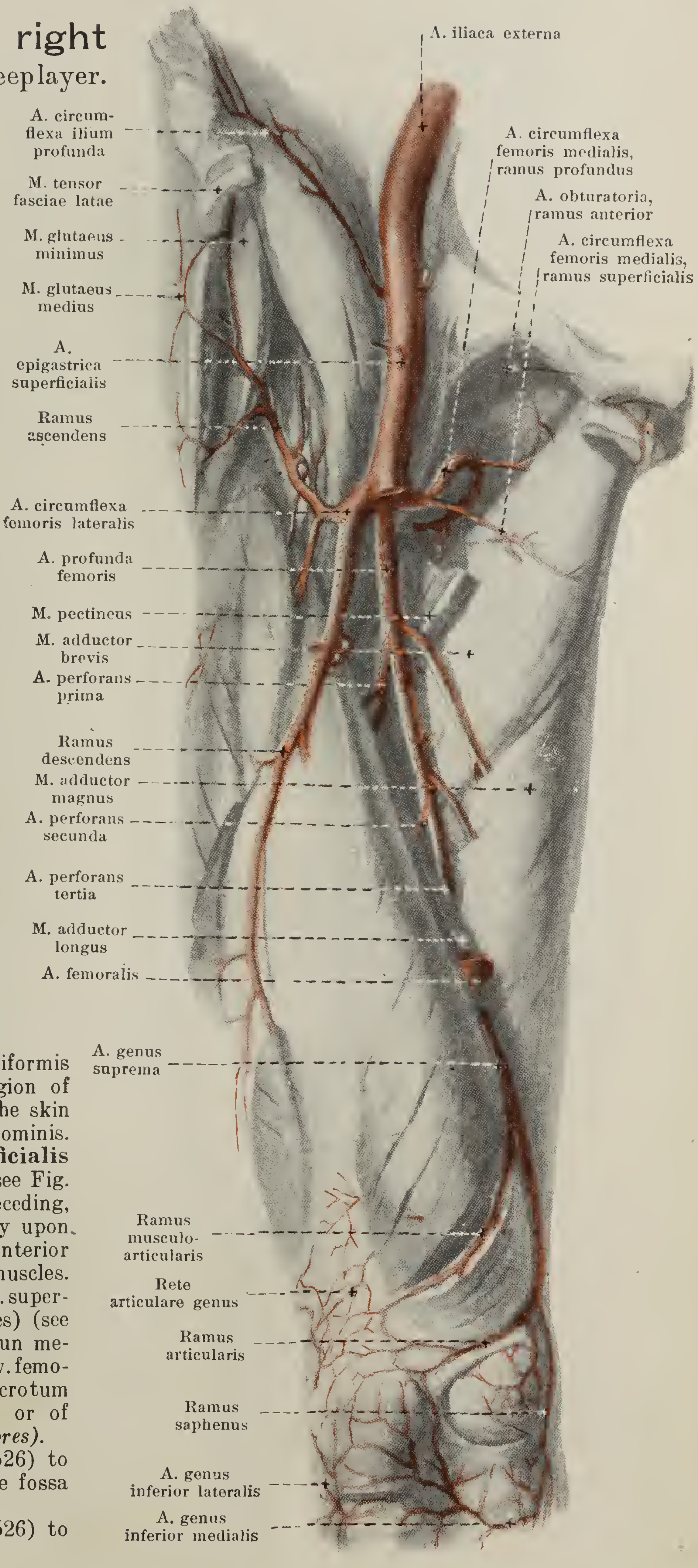
1. **A. epigastrica inferior** (O. T. deep epigastric artery) (see Figs. 501, 518, 519 and 521) arises just above the lig. inguinale and runs in a curve, first obliquely medianward, then vertically upward. In its course it lies at first behind the lig. inguinale and lig. interfoveolare, medial from the annulus inguinalis abdominalis and then, passing behind the tendon of the m. transversus abdominis, arrives at the posterior surface of the m. rectus abdominis. It causes the peritonaeum to bulge forward to form the plica epigastrica (see also Figs. 379 and 650) and thus separates the fovea inguinalis medialis and the fovea inguinalis lateralis from each other. Finally it sinks into the substance of the m. rectus abdominis, supplies this muscle and a part of the skin covering it, and anastomoses freely with the a. epigastrica superior. Branches:

a) *Ramus pubicus* (see Fig. 518) goes medianward behind the pelvic attachment of the m. transversus abdominis just above the ramus superior ossis pubis and gives off the ***ramus obturatorius***, which runs downward behind the lig. lacunare [Gimbernati] to the ramus pubicus of the a. obturatoria (see p. 445).

b) *A. spermatica externa* (O. T. ceremasteric branch) (in the male) (see Fig. 519), *a. ligamenti teretis uteri* (in the female), perforates the posterior wall of the inguinal canal, enters the spermatic cord or the lig. teres uteri and spreads out in the tunics of the testicle, or in the lig. teres and in the labia majora.

527. Arteries of the right thigh, viewed from in front, deep layer.

(The mm. sartorius, tensor fasciae latae, rectus femoris, pectineus, adductor longus and gracialis have been removed. A large portion of the a. femoralis has been cut off.)



2. **A. circumflexa ilium profunda** (deep circumflex iliac artery) (see also Figs. 514, 518 and 519) arises behind or below the lig. inguinale, passes (at first in a duplicature of the fascia iliaca, then upon the latter) lateralward and upward in the groove between the mm. transversus abdominis and iliacus, gives off small branches to the neighboring muscles, as well as one larger branch upward between the mm. transversus and obliquus internus (see Fig. 501) and extends backward along the crista iliaca; anastomosis with the r. iliacus a. iliolumbalis.

A. femoralis (femoral artery) (see also Fig. 526) follows a fairly straight course, in the groove between the mm. pectineus and adductores on the one hand, the m. iliopsoas and m. vastus medialis on the other, downward and medianward and finally through the canalis adductorius. It lies above upon the deep layer of the fascia lata and is covered, from the inferior angle of the trigonum femorale on, by the m. sartorius. Above, it lies lateralward from the v. femoralis, farther down, it lies in front of the same (see also Fig. 556). Branches:

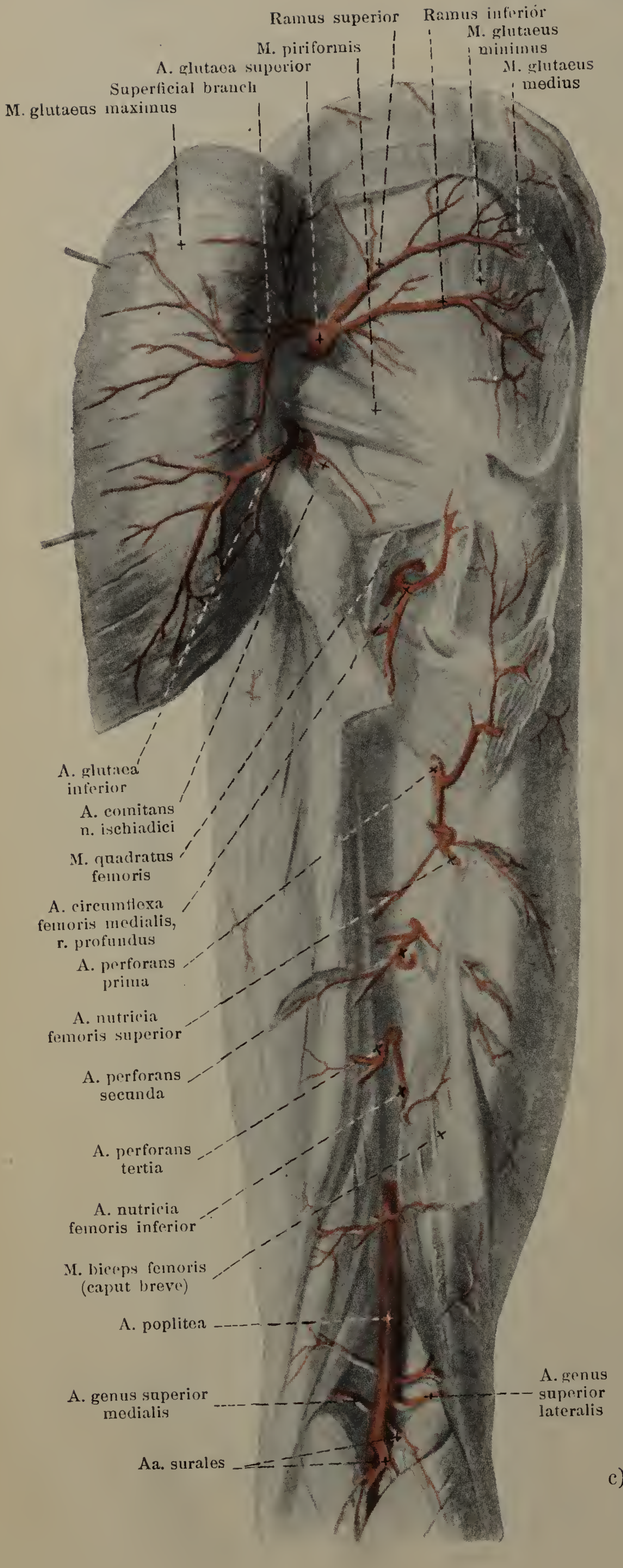
1) **A. epigastrica superficialis** (superficial epigastric artery) (see Fig. 526) arises just below the lig. inguinale, perforates the margo falciformis and runs upward as far as the region of the navel; it gives off branches to the skin and to the m. obliquus externus abdominis.

2) **A. circumflexa ilium superficialis** (superficial circumflex iliac artery) (see Fig. 526), frequently a branch of the preceding, goes lateralward, usually superficially upon the fascia lata, to the spina iliaca anterior superior and supplies the skin and muscles.

3) **Aa. pudendae externae** (O. T. superficial and deep external pudic arteries) (see Fig. 526), usually two in number, run medianward, in front of and behind the v. femoralis to the anterior surface of the scrotum and penis *(aa. scrotales anteriores)* or of the labia majora *(aa. labiales anteriores)*.

4) **Rami inguinales** (see Fig. 526) to the lymph glands and muscles of the fossa iliopectinea.

5) **Rami musculares** (see Fig. 526) to the neighboring muscles and skin.



528.

Arteries of the right thigh, viewed from behind.

(The m. glutaeus maximus has been reflected inward, the mm. glutaeus medius, quadratus femoris and caput longum m. bicipitis have been partially removed.)

6) **A. genus suprema** (O. T. anastomotica magna) (see Fig. 527) goes off in the canalis adductorius, perforates the lamina vastoadductoria (see also p. 772), runs downward between it and the m. sartorius behind the epicondylus medialis femoris and finally accompanies the n. saphenus for a variable distance *(ramus saphenus).* It gives off *rami musculares,* as well as a *ramus musculoarticularis* (O. T. deep branch) in the m. vastus medialis and *rami articulares* (O. T. superficial branch) below the same to the *rete articulare genus.*

7) **A. profunda femoris** (O. T. profunda or deep femoral artery) (see also Figs. 526 and 527) arises in the fossa iliopectinea and descends behind the a. femoralis and a little lateral from it. It runs in front of the mm. iliopsoas, pectineus and adductor brevis, behind the m. adductor longus, and ends as the a. perforans tertia. Branches:

a) *A. circumflexa femoris medialis* (O. T. internal circumflex artery) goes off near the origin and runs medianward behind the a. and v. femoralis. Branches:

aa) *Ramus superficialis,* in front of the m. pectineus, medianward between the mm. adductores longus and brevis.

ab) *Ramus profundus,* a larger branch, bends upward, passes backward between the mm. iliopsoas and pectineus and, below the m. obturator externus, to the anterior surface of the m. quadratus femoris. It sends branches to the hip-joint and divides into a branch ascending to the fossa trochanterica, and a branch descending behind the adductor muscles; it supplies the neighboring muscles and skin.

b) *A. circumflexa femoris lateralis* (O. T. external circumflex artery) lateralward in front of the m. iliacus. Branches:

ba) *Ramus ascendens,* goes upward and lateralward beneath the m. rectus femoris to the mm. glutaei and tensor fasciae and to the fossa trochanterica.

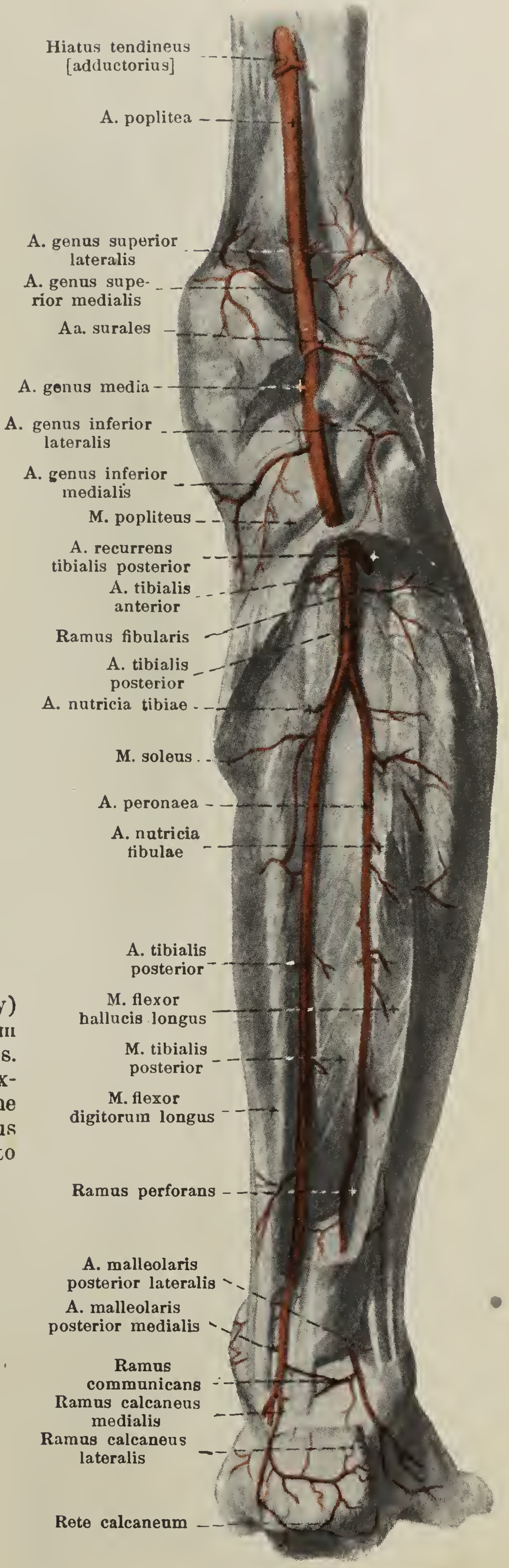
bb) *Ramus descendens,* a larger branch, downward and lateralward beneath the m. rectus femoris between the mm. vasti intermedius and lateralis almost to the knee; it also gives off branches to the skin.

c) *A. perforans prima* (O. T. superior or first perforating artery) perforates the adductors at the lower margin of the m. pectineus.

529. Arteries of the right leg,

viewed from behind.

(The muscles of the thigh with the exeption of the m. adductor magnus have been completely removed; the mm. gastrocnemius, plantaris, soleus and flexor hallucis longus have been partially removed.)


Hiatus tendineus [adductorius]
A. poplitea
A. genus superior lateralis
A. genus superior medialis
Aa. surales
A. genus media
A. genus inferior lateralis
A. genus inferior medialis
M. popliteus
A. recurrens tibialis posterior
A. tibialis anterior
Ramus fibularis
A. tibialis posterior
A. nutricia tibiae
M. soleus
A. peronaea
A. nutricia fibulae
A. tibialis posterior
M. flexor hallucis longus
M. tibialis posterior
M. flexor digitorum longus
Ramus perforans
A. malleolaris posterior lateralis
A. malleolaris posterior medialis
Ramus communicans
Ramus calcaneus medialis
Ramus calcaneus lateralis
Rete calcaneum

d) *A. perforans secunda* (see Figs. 527 and 528) perforates the adductors at the lower margin of the m. adductor brevis.

e) *A. perforans tertia* (see Figs. 527 and 528) perforates the adductors somewhat above the canalis adductorius.

All three aa. perforantes supply the adductors and the muscles and skin of the posterior surface.

The *a. nutricia femoris* is usually single and given off by the a. perforans II; more rarely it is double *(superior* and *inferior)* and then comes from the aa. perforantes I and III.

A. poplitea (popliteal artery) (see also Fig. 528) runs downward, from the hiatus tendineus [adductorius], behind the planum popliteum femoris, upon the capsula articularis of the knee-joint, upon the posterior surface of the m. popliteus and in front of the tendinous arch between the origins of the m. soleus and divides just below the latter into the ***a. tibialis posterior*** and the ***a. tibialis anterior***. In its course it is covered above by the m. semimembranosus, in the popliteal space, behind and somewhat lateralward, by the v. poplitea and (behind this) is overlapped by the n. tibialis; below, it is hidden beneath the mm. gastrocnemius and plantaris. Branches:

1) **A. genus superior lateralis** (O. T. superior external articular artery) (see also Fig. 530) goes, above the condylus lateralis femoris, directly upon the bone to the ***rete articulare genus.***

2) **A. genus superior medialis** (O. T. superior internal articular artery) like the preceding, above the condylus medialis femoris.

3) **A. genus media** (O. T. azygos articular artery) perforates the capsule above the lig. popliteum obliquum and goes to the ligg. cruciata and to the synovial folds.

4) **A. genus inferior lateralis** (O. T. inferior external articular artery) (see also Fig. 530) goes upon the m. popliteus, along the upper margin of the condylus lateralis tibiae, covered by the lig. collaterale fibulare, to the ***rete articulare genus.***

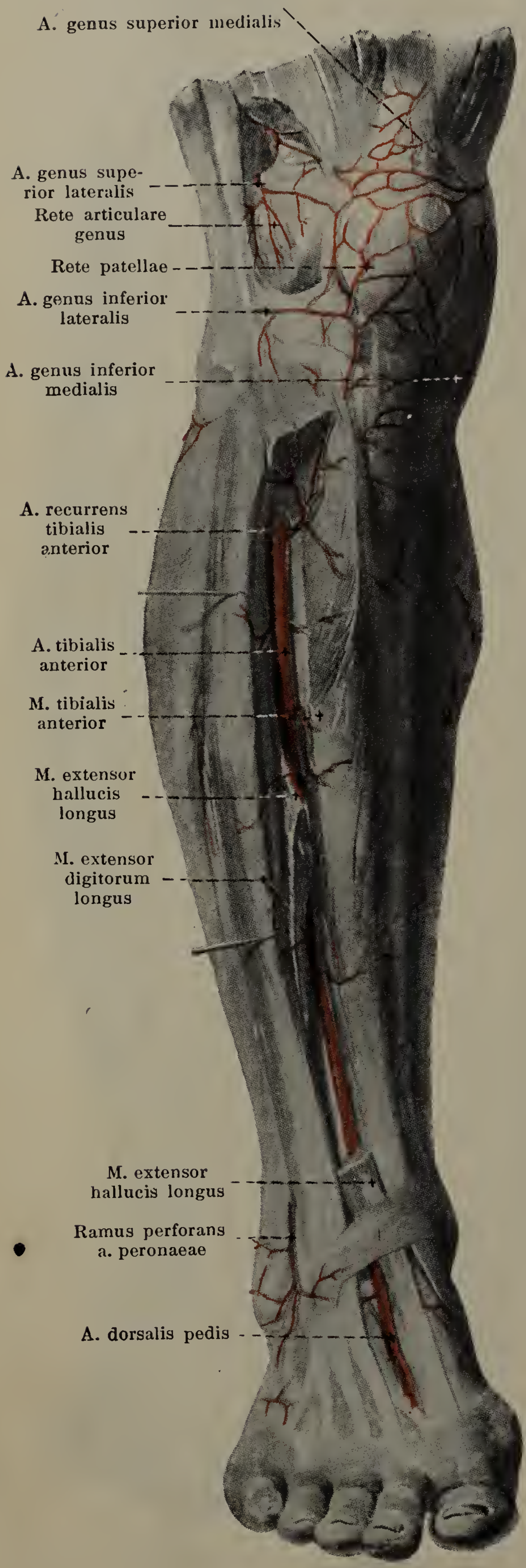
5) **A. genus inferior medialis** (O. T. inferior internal articular artery) (see also Fig. 527) goes, below the condylus medialis tibiae, covered by the lig. collaterale tibiale, to the ***rete articulare genus.***

6) **Aa. surales,** several, sometimes from one trunk, to the m. triceps surae and to the skin.

A. tibialis posterior (posterior tibial artery) extends downward and medianward in front of the m. triceps surae upon the posterior surface of the m. tibialis posterior in the groove between the mm. flexores digitorum longus and hallucis longus, above in front of the n. tibialis, elsewhere medianly of it, covered by the deep layer of the fascia cruris. Below, it runs in front of the medial margin of the tendon of Achilles in a curve to the regio retromalleolaris medialis lying there nearly in the middle between the malleolus medialis and the tendo calcaneus and there divides into the *aa. plantares medialis* and *lateralis.* It gives off branches, to the muscles and to the skin and farther:

530. Arteries of the right leg, viewed from in front.

(The mm. tibialis anterior and extensor hallucis longus have been partially removed.)


A. genus superior medialis
A. genus superior lateralis
Rete articulare genus
Rete patellae
A. genus inferior lateralis
A. genus inferior medialis
A. recurrens tibialis anterior
A. tibialis anterior
M. tibialis anterior
M. extensor hallucis longus
M. extensor digitorum longus
M. extensor hallucis longus
Ramus perforans a. peronaeae
A. dorsalis pedis

1. **Ramus fibularis** (see Fig. 529) extends lateralward toward the collum fibulae to the mm. soleus and peronaeus longus.

2. **A. peronaea** (peroneal artery) (see Fig. 529) arises just below the collum fibulae and runs downward on the posterior surface of the m. tibialis posterior, between it and the m. flexor hallucis longus, near the fibula; below, it lies upon the posterior surface of the membrana interossea cruris or of the tibia and breaks up behind the ankle-joint into the *rami calcanei laterales* (O. T. exteral calcaneal arteries) which go to the *rete calcaneum* and its neighborhood. Numerous branches to the muscles, and further:

a) *A. nutricia fibulae* (see Fig. 529) into the canalis nutricius fibulae.

b) *Ramus perforans* (O. T. anterior peroneal artery) (see also Figs. 529 and 531) perforates the membrana interossea just above the syndesmosis tibiofibularis, unites with the a. malleolaris anterior lateralis and helps to form the *rete malleolare laterale* and the *rete calcaneum.*

c) *A. malleolaris posterior lateralis* (see Fig. 529), directly upon the fibula, to the *rete malleolare laterale.*

d) *Ramus communicans* (see Fig. 529), upon the posterior surface of the tibia, just above the ankle joint, to the a. tibialis posterior.

3. **A. nutricia tibiae** (see Fig. 529) into the canalis nutricius tibiae.

4. **A. malleolaris posterior medialis** (O. T. internal malleolar branch) (see Fig. 529), directly upon the tibia to the *rete malleolare mediale.*

5. **Rami calcanei mediales** (O. T. internal calcaneal branches) (see Figs. 529 and 532) form, with the rami calcanei laterales (see above), the *rete calcaneum,* which is situated superficially upon the tuber calcanei, as well as upon the surrounding muscles and tendons.

A. tibialis anterior (anterior tibial artery) goes forward above the membrana interossea cruris and directly downward upon its anterior surface. Above, it lies between the m. tibialis anterior and the m. extensor digitorum longus, below, between the former muscle and the m. extensor hallucis longus. Farther down, it is situated upon the anterior surface of the tibia and of the capsule of the upper ankle-joint, as well as behind the m. extensor hallucis longus and the deep layer of the lig. cruciatum cruris and there becomes continuous with the *a. dorsalis pedis.* It gives off numerous branches to the muscles and skin, and farther:

1. **A. recurrens tibialis posterior** (posterior tibial recurrent artery) (see Fig. 529), which comes off at the beginning of the artery, extends, behind the fibula, to the articulatio tibiofibularis. It is often absent.

2. **A. recurrens tibialis anterior** (anterior tibial recurrent artery) upward, upon the anterior surface of the condylus lateralis tibiae, to the *rete articulare genus,* which is spread out partly upon the bones and ligaments of the knee joint, partly upon the tendon of the m. quadriceps femoris, upon the lig. patellae and upon the patella itself *(rete patellae).*

531. Arteries of the back of the right foot.

3) **A. malleolaris anterior lateralis** (O. T. external malleolar artery) to the malleolis lateralis, unites with the ramus perforans of the a. peronaea and helps to form the *rete malleolare laterale* upon the lateral malleolus and its neighborhood.

4) **A. malleolaris anterior medialis** (O. T. internal malleolar artery) goes to the malleolus medialis and helps to form the *rete malleolare mediale,* situated there.

A. dorsalis pedis (see also Fig. 530) extends forward, upon the ligaments and bones of the back of the foot, between the mm. extensores hallucis longus and brevis and breaks up between the proximal ends of the ossa metatarsalia I and II into the *ramus plantaris profundus* and the *a. metatarsea dorsalis I.* Branches:

1. **Aa. tarseae mediales** (O. T. internal tarsal artery), 2—3, run upon the bones and ligaments to the medial border of the foot and help to form the *rete malleolare mediale.*

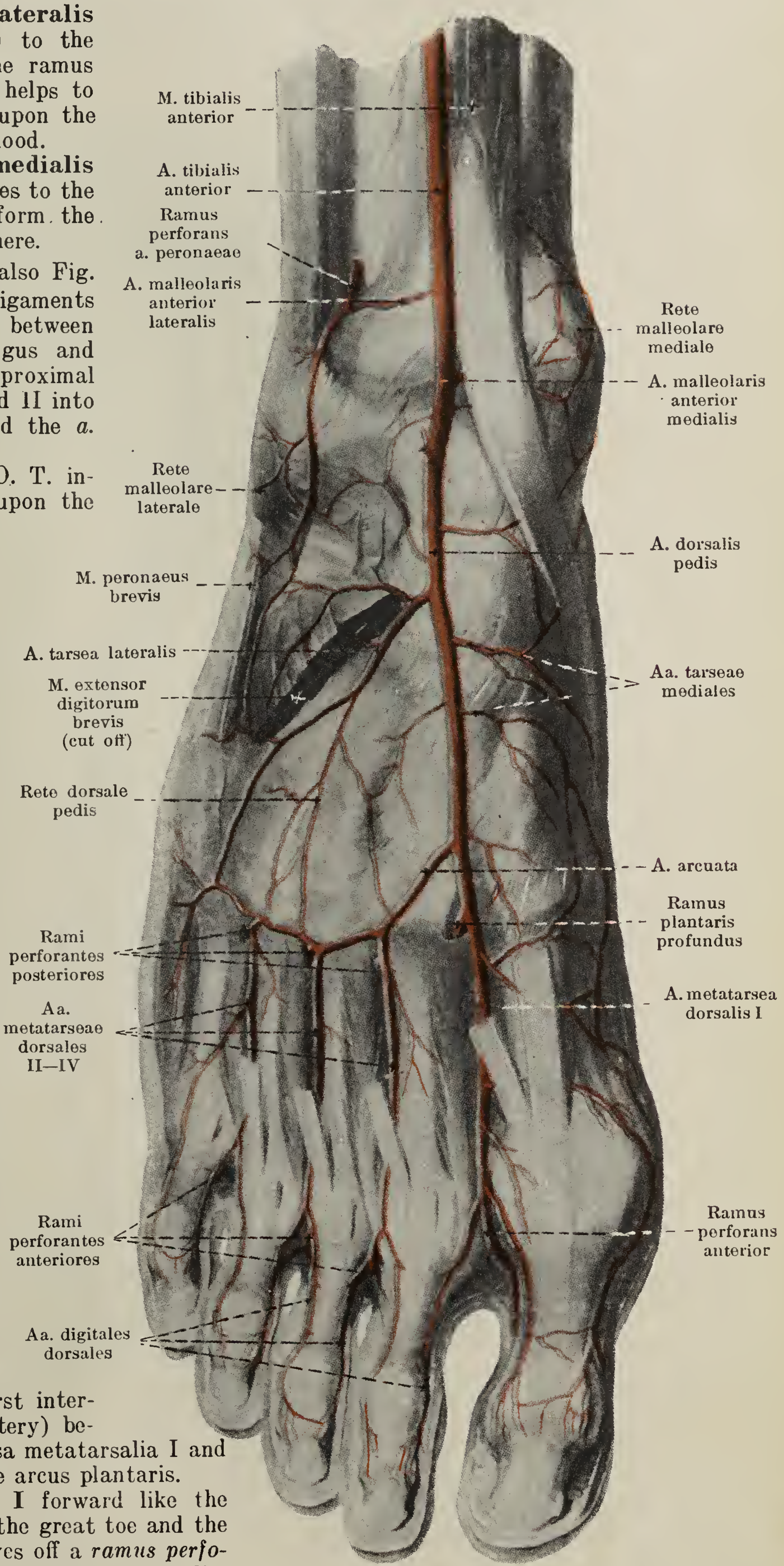
2. **A. tarsea lateralis** (O. T. external tarsal artery) lateralward and forward upon the bones and ligaments, covered by the m. extensor digitorum brevis, toward the basis ossis metatarsalis V, unites there with the lateral end of the a. arcuata. Branches which anastomose with one another and, with branches of the a. dorsalis pedis and a. arcuata, form the *rete dorsale pedis.*

3. **A. arcuata** (O. T. metatarsal artery) lateralward directly upon the proximal ends of the ossa metatarsalia unites with the a. tarsea lateralis. Branches:

a) *Aa. metatarseae dorsales II to IV* (O. T. tarsal interosseous arteries) run forward upon the 2nd—4th m. interosseus dorsalis and each divides into two *aa. digitales dorsales* (dorsal digital arteries) behaving just as do the arteries to the fingers. Larger *rami perforantes posteriores* and smaller, inconstant *anteriores* between the proximal or between the distal side of the ossa metatarsalia go to the aa. metatarseae plantares.

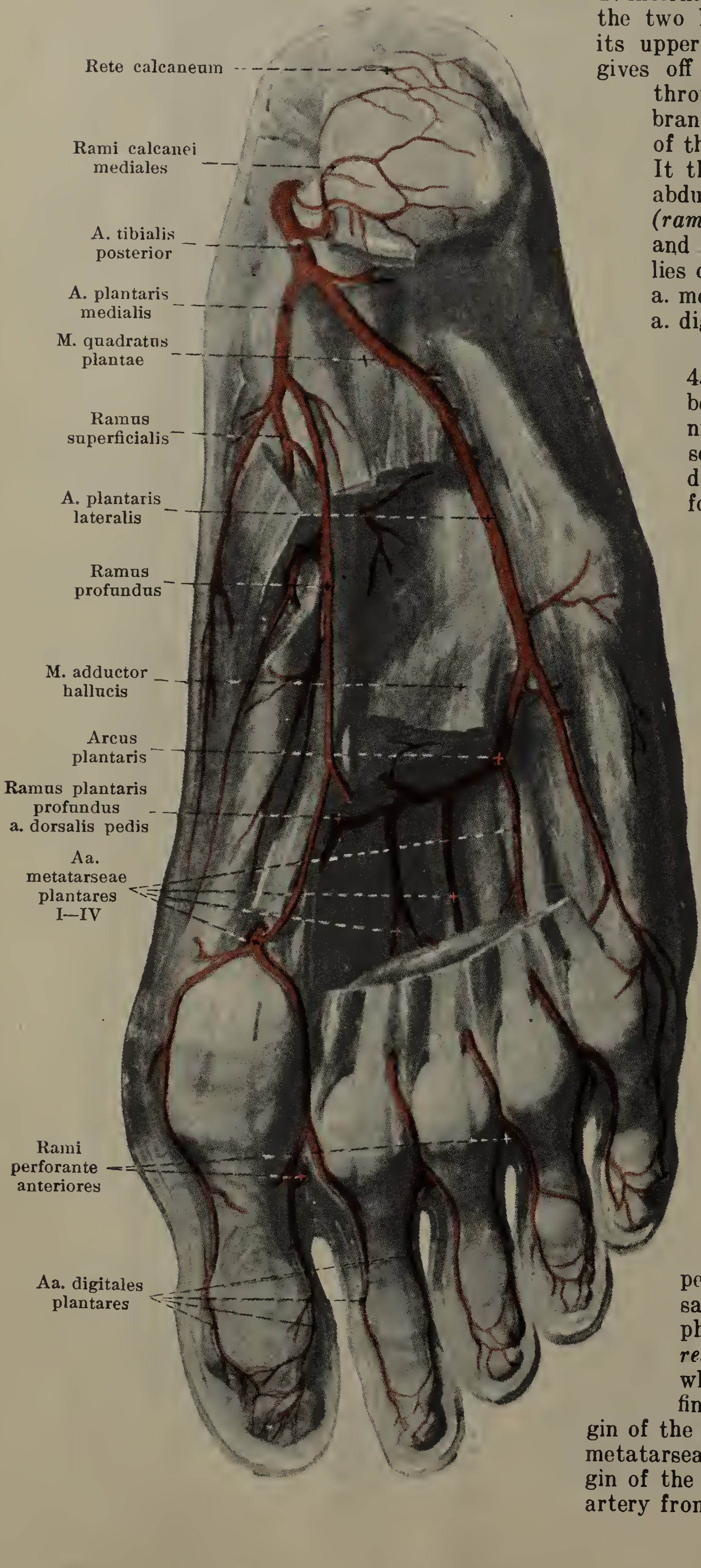
4. **Ramus plantaris profundus** (O. T. communicating, first interosseous perforating or plantar artery) between the proximal ends of the ossa metatarsalia I and II, into the sole of the foot, to the arcus plantaris.

5. **A. metatarsea dorsalis I** forward like the other aa. metatarseae dorsales to the great toe and the medial surface of the 2nd toe; it gives off a *ramus perforans anterior* between the heads of the ossa metatarsalia.



532. Arteries of the sole of the right foot.

(The muscles have, for the most part, been removed.)

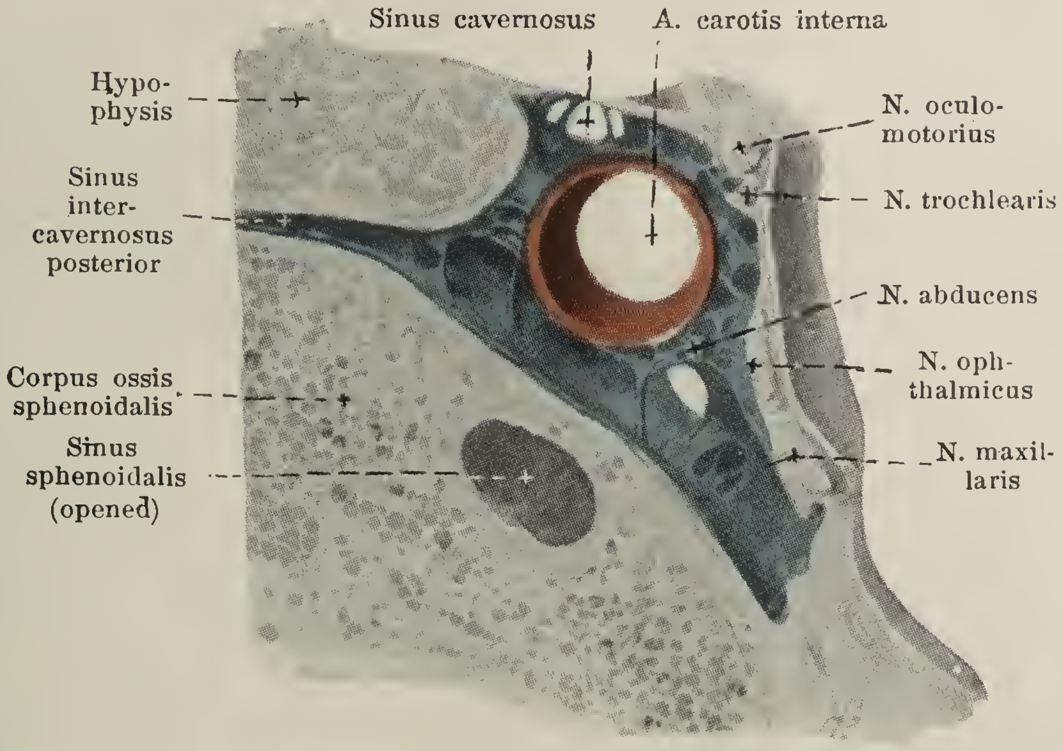


A. plantaris medialis (see p. 455) (O. T. internal plantar artery) goes forward, between the two layers of the lig. laciniatum (through its upper compartment, see p. 379), and there gives off the *ramus superficialis*, which passes through the m. abductor hallucis, giving off branches to it, arrives at the medial margin of the foot and runs as far as the great toe. It then enters the groove between the mm. abductor hallucis and flexor digitorum brevis *(ramus profundus)*, supplies these muscles and the skin and goes, between the two bellies of the m. flexor hallucis brevis, into the a. metatarsea plantaris I or into the medial a. digitalis plantaris of the great toe.

A. plantaris lateralis (see p. 455) (O. T. external plantar artery) runs, between the two layers of the lig. laciniatum (through its lower compartment see p. 379), then between the mm. flexor digitorum brevis and quadratus plantae, forward and lateralward toward the basis ossis metatarsalis V; there it lies more superficially, between the mm. quadratus plantae and flexor digiti V and bends around medianward into the arcus plantaris. It gives off branches to the neighboring bones, ligaments, muscles and skin.

The **arcus plantaris** lies directly beneath the proximal ends of the 2nd to the 4th metatarsal bone and beneath the mm. interossei, between them and the caput obliquum of the m. adductor hallucis, being more superficial lateralward than medianward It diminishes in caliber from the lateral toward the medial margin of the foot, arises, lateralward, directly from the a. plantaris lateralis and unites medianward, between the ossa metatarsalia I and II, with the ramus plantaris profundus of the a. dorsalis pedis. It gives off recurrent branches to the bones and muscles; running forward from it are the 4 *aa. metatarseae plantares* (O. T. digital or plantar digital arteries). Each of these passes forward between two metatarsal bones, receives the rami perforantes of the aa. metatarseae dorsales and divides at the bases of the first phalanges into the *aa. digitales plantares* (O. T. collateral digital arteries), which behave just as do those to the fingers. The artery for the medial margin of the great toe is usually given off by the a. metatarsea plantaris I; that for the lateral margin of the little toe arises usually as a separate artery from the end of the a. plantaris lateralis.

533. Frontal section through the right sinus cavernosus, viewed from behind. Magnification: 5:2.



The **sinus durae matris** *(sinuses of the dura mater)* are venous canals which run, chiefly, between the divergent layers of the dura mater and lie at the same time in corresponding bony grooves. They stand open on section and are devoid of valves; the sinus sagittalis superior and cavernosus are crossed in a network-like manner by bands of connective tissue. They receive the *vv. cerebri, meningeae, diploicae* (partially), *auditivae internae* and the *vv. ophthalmicae.*

1. **Sinus transversus** (O. T. lateral sinus) (see Figs. 534 and 535), paired, collects most of the blood from the skull cavity. It begins on each side at the protuberantia occipitalis interna; it is usually larger on the right than on the left side and runs curved lateralward in the sulcus transversus of the occipital bone and of the parietal bone, in the attached margin of the tentorium cerebelli. Thence, it goes tortuous medianward and downward, in the sulcus sigmoideus of the temporal bone and in the sulcus transversus of the pars lateralis oss. occipitalis, to the foramen jugulare to become continuous there with the upper end of the v. jugularis interna. In the region of the tentorium cerebelli it is triangular-prismatic in shape, elsewhere semi-cylindrical.

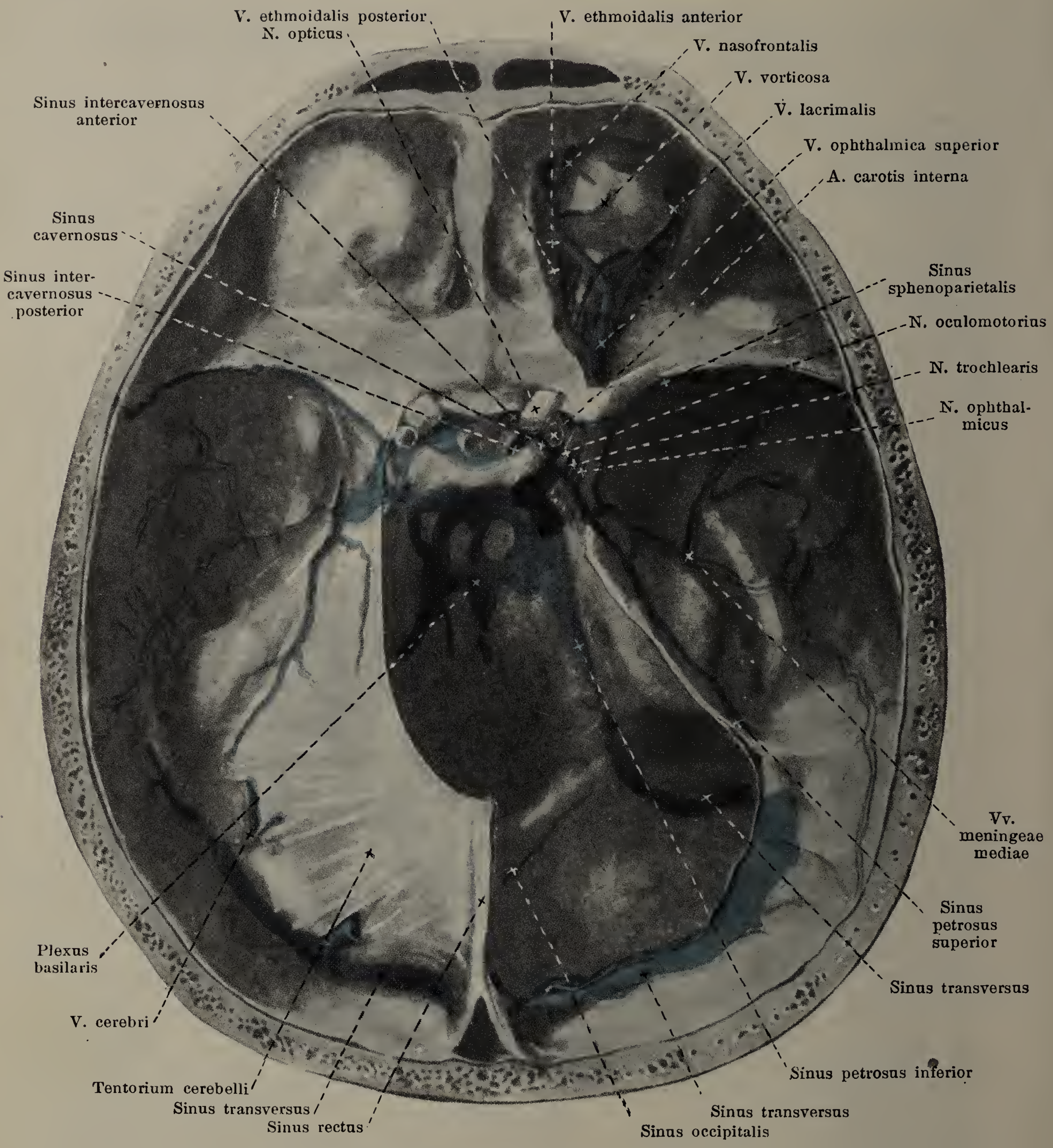
2. **Sinus sagittalis superior** (O. T. superior longitudinal sinus) (see Figs. 534, 535, 815 and 816), unpaired, extends from before backward, in a curve, in the attached margin of the falx cerebri near the crista frontalis and in the sulcus sagittalis of the frontal bone, of the parietal bones and of the occipital bone. It opens very often with a right, larger branch into the right and with a left, smaller branch into the left sinus transversus; nearly as often it opens undivided into the right, seldom undivided into the left sinus transversus. It is triangular in transverse section. The sinus anastomoses with the sinus sagittalis inferior.

3. **Sinus sagittalis inferior** (O. T. inferior longitudinal sinus) (see Figs. 534 and 535), unpaired, from before backward in the free margin of the falx cerebri, into the sinus rectus.

4. **Sinus rectus** (straight sinus) (see Figs. 534, 535 and 815), unpaired, goes as continuation of the preceding and after picking up the v. cerebri magna [Galeni], as a triangular canal, at the point of attachment of the falx cerebri to the tentorium cerebelli, from in front and above, backward and downward; it opens sometimes undivided into the left sinus transversus, but usually divided with a left, larger branch into the left and with a right, smaller branch into the right sinus transversus. Sometimes in front of the protuberantia occipitalis interna exists a cavity *(confluens sinuum)*, into which the sinus sagittalis superior and the sinus rectus open undivided and from which go off both sinus transversi.

5. **Sinus occipitalis** (see Figs. 534 and 535), unpaired or paired, begins at the protuberantia occipitalis interna and goes downward, close to the median plane in the attached margin of the falx cerebelli. Above, it begins oftener divided than single at the beginning of the sinus transversi. Below, it bifurcates, turns lateralward and forward on both sides above the foramen occipitale magnum and enters the sinus transversus, close to the foramen jugulare. It anastomoses with the plexus venosi vertebrales interni and varies much in the degree of its development.

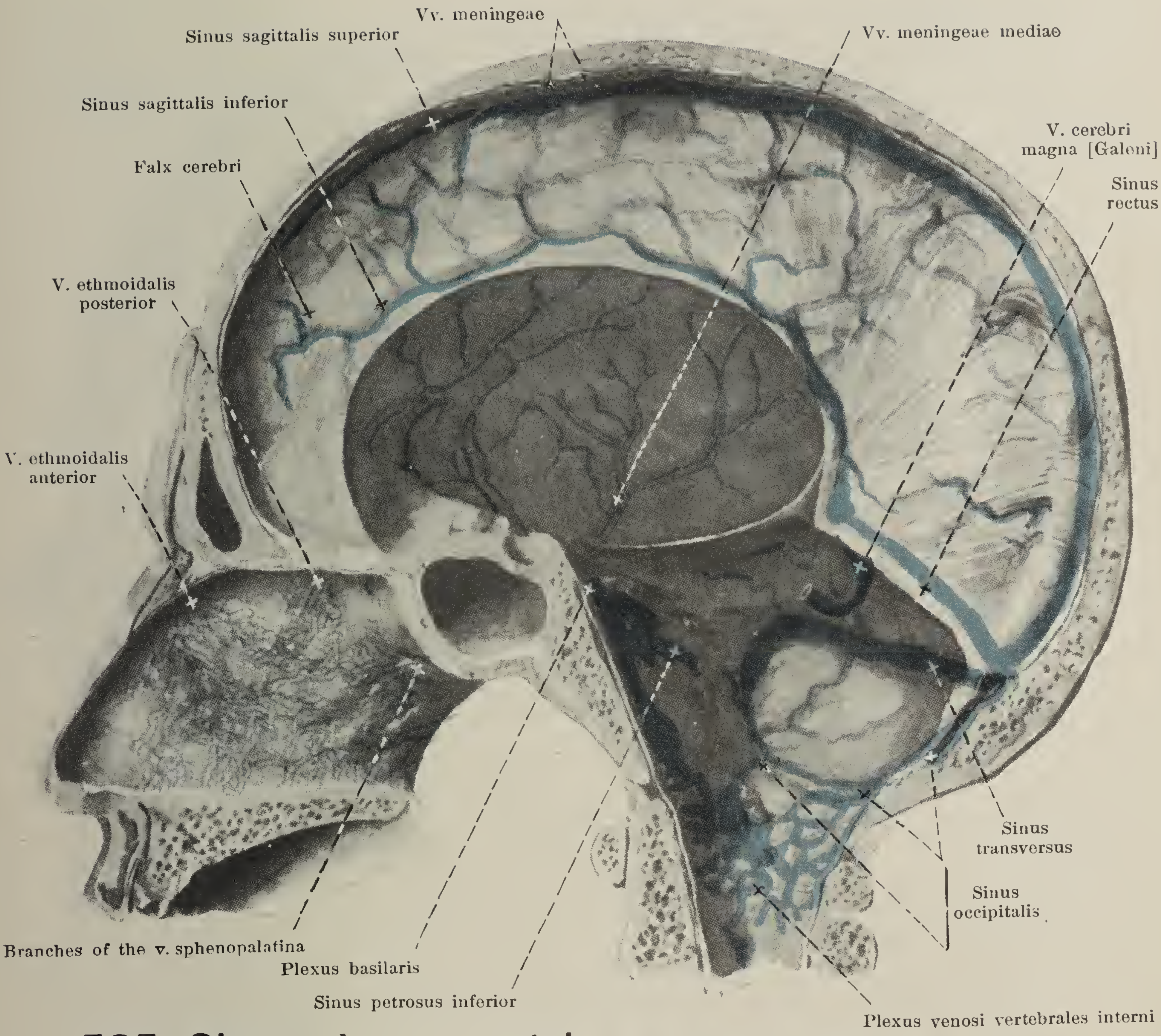
6. **Sinus cavernosus** (see also Figs. 493, 534 and 535), paired, is an irregular space, which is situated, on each side, near the sella turcica and the corpus oss. sphenoidalis. It is bounded above and lateralward by that part of the dura mater which is stretched out from the procc. clinoidei anterior and posterior to the angulus superior pyramidis and to the middle skull fossa (see also p. 709); it surrounds, in addition, the a. carotis interna, the n. abducens and the plexus cavernosus. Tributaries:



534. Sinus durae matris, viewed from above.

(The right orbit and sinus cavernosus have been opened; the tentorium has been cut away.)

a) *V. ophthalmica superior* (superior ophthalmic vein) (see also Figs. 539, 915, 916 and 919), devoid of valves, corresponds only approximately to the a. ophthalmica, which possesses, in addition, two delicate accompanying veins. It anastomoses freely above the lig. palpebrale mediale by its anterior extremity *(v. nasofrontalis)* (see Figs. 538 and 539) with the v. angularis (of the v. facialis anterior), runs backward near the m. obliquus superior, then lateralward between the n. opticus and the m. rectus superior, finally backward through the fissura orbitalis superior into the sinus cavernosus, laterally and above the annulus tendineus communis; it sends an anastomosis to the v. ophthalmica inferior. It receives the *vv. ethmoidales anterior et posterior, v. lacrimalis, vv. musculares* and the veins of the bulbus oculi and of the eyelids (see p. 802; the *v. centralis retinae* opens into the sinus cavernosus).



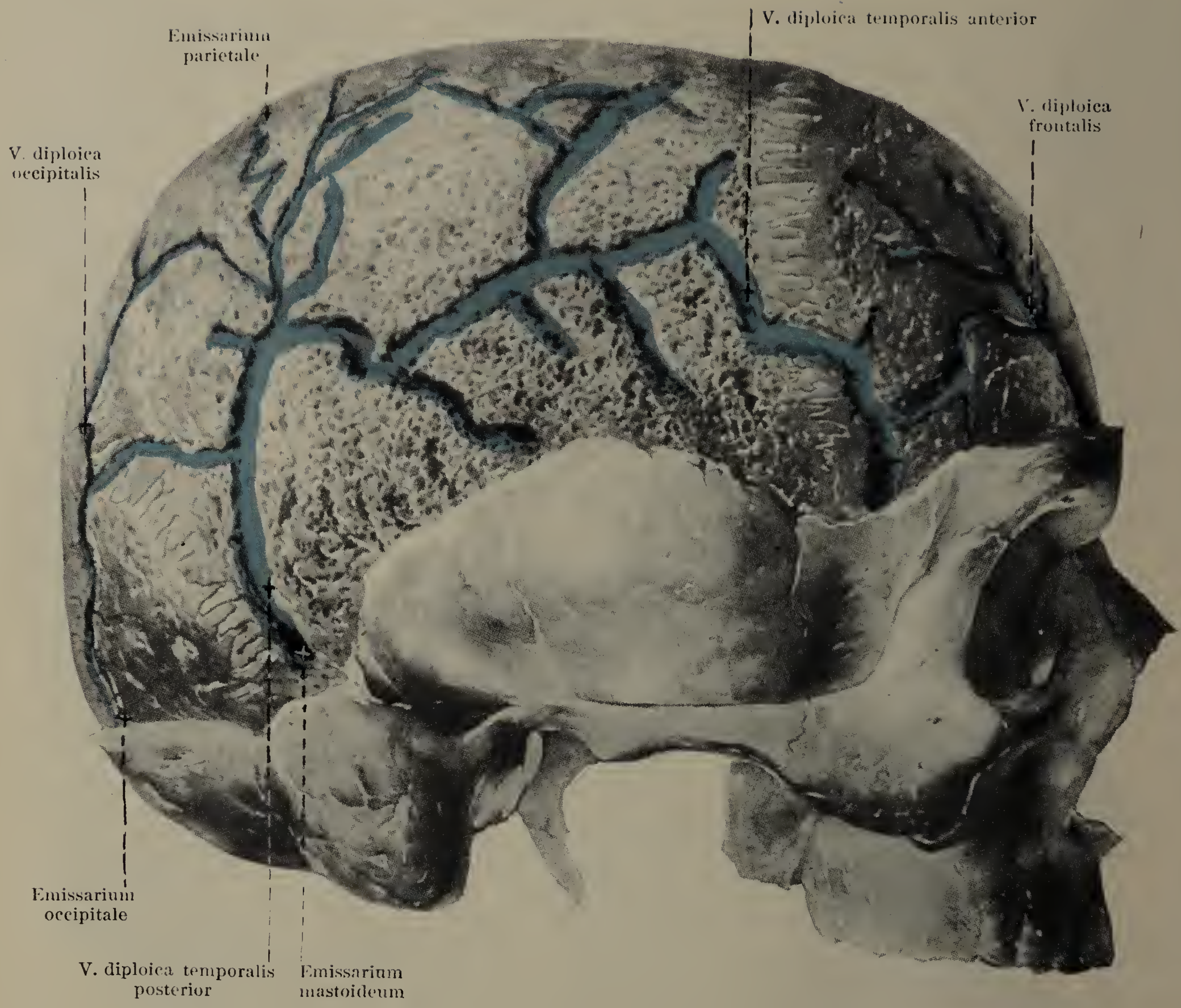
535. Sinus durae matris of the right half of the skull, viewed from the left.

b) *V. ophthalmica inferior* (see Figs. 539, 915 and 916), devoid of valves, arises from the veins of the tear-sac, of the eyelids, &c., in the anterior part of the orbit, between the medial and inferior wall; it runs in the inferior part of the orbit and divides into two branches. One branch goes backward through the fissura orbitalis superior (below the annulus tendineus communis [Zinni]) into the sinus cavernosus; the other passes lateralward through the fissura orbitalis inferior and opens into the ramus profundus of the v. facialis anterior. It receives *vv. musculares* and veins of the bulbus oculi and anastomoses medianward with the v. ophthalmica superior.

c) *Sinus sphenoparietalis* (see Fig. 534), paired, begins on each side a little behind the sutura coronalis on the parietal bone in a bony groove or in a bony canal, turns medianward beneath the ala parva ossis sphenoidalis and enters the anterior end of the sinus cavernosus. It receives usually one *v. meningea media, vv. cerebri inferiores* (from the fissura cerebri lateralis [Sylvii]), as well as the *v. ophthalmomeningea,* and also the *v. diploica temporalis anterior.*

7. and 8. **Sinus intercavernosus anterior** and **sinus intercavernosus posterior** (see Fig. 534), unpaired, run in front of, behind and partly also beneath, the hypophysis and unite the two sinus cavernosi with each other. They form, with these, the **sinus circularis.**

9. **Sinus petrosus superior** (superior petrosal sinus) (see Fig. 534), paired, goes lateralward and backward on each side, from the posterior part of the sinus cavernosus in the sulcus petrosus superior of the temporal bone and in the attached margin of the tentorium cerebelli, to the sulcus sigmoideus and into the sinus transversus.



536. Venae diploicae, viewed from the right.

(The lamina externa of the roof of the skull has been filed off.)

10. **Sinus petrosus inferior** (inferior petrosal sinus) (see Figs. 534 and 535) paired, extends lateralward and downward on each side from the posterior, inferior portion of the sinus cavernosus in the sulcus petrosus inferior of the occipital and temporal bone to the foramen jugulare and runs downward through its most anterior subdivision; it opens, either in the foramen jugulare or below it, into the bulbus v. jugularis superior.

11. **Plexus basilaris** (see Figs. 534 and 535), unpaired, lies as a plexus upon the clivus and is connected above, on both sides, with the sinus cavernosus and the sinus petrosus inferior, below, at the foramen occipitale magnum, with the plexus venosi vertebrales interni.

Vv. cerebri collect the blood partly from the surface, partly from the interior of the brain (see also p. 674) and open particularly into the sinus sagittalis superior, transversus, sphenoparietalis, petrosus superior and rectus; they possess no valves.

Vv. meningeae (see Figs. 534 and 535) stand open, are devoid of valves, are numerous in the dura mater encephali, are connected above with the sinus sagittalis superior and anastomose manifoldly with one another. They accompany the stems of the corresponding arteries, there being usually two veins to one artery, and open into a neighboring sinus. The *vv. meningeae mediae*, usually two in number, run near the a. meningea media, are connected with the sinus sphenoparietalis and sometimes with the rete foraminis ovalis, extend downward through the foramen spinosum and open into the plexus pterygoideus.

Vv. auditativae internae (see p. 856) (not illustrated) come from the internal ear through the meatus acusticus internus and open into the sinus transversus or the sinus petrosus inferior.

Venae diploicae (see Fig. 536) are thin walled tubes, which lie in the flat *canales diploici [Brescheti]* in the substance of the bones of the roof of the skull. They have no valves; they are arranged in the form of a network and are very variable. The main stems run from above downward and are connected at their extremities by openings *(emissaria)* with the external veins of the skull or witht he sinus durae matris or (usually) with both at the same time; they possess valves alone at their mouths which generally allow a flowing off outward only.

1) *V. diploica frontalis* opens into the v. supraorbitalis and the sinus sagittalis superior.
2) *V. diploica temporalis anterior* into a v. temporalis profunda and the sinus sphenoparietalis.
3) *V. diploica temporalis posterior* from the emissarium pariet. to the emissarium mastoid..
4) *V. diploica occipitalis* opens into the emissarium occipitale.

Emissarium parietale, in the foramen parietale, unites the sinus sagittalis superior with the superficial veins of the skull; its valves permit a flow in an outward direction only.

Emissarium mastoideum, in the foramen mastoideum, between the sinus transversus and the v. auricularis posterior or the v. occipitalis or the beginning of the v. jugularis externa.

Emissarium occipitale, at the level of the protuberantiae occipitales, opens usually either internally into a sinus transversus or into the confluens sinuum, externally into the v. occipitalis, often into both.

Emissarium condyloideum (not illustrated), in the canalis condyloideus, unites the sinus transversus and the plexus venosi vertebrales externi.

Plexus venosus caroticus internus (see Fig. 493) surrounds the a. carotis interna in the canalis caroticus in the form of a network, is connected above with the sinus cavernosus, receives veins from the cavum tympani and opens below into the v. jugularis interna.

Rete foraminis ovalis (not illustrated) in the foramen ovale from the sinus cavernosus to the plexus pterygoideus; it is often connected above with the vv. meningeae mediae.

Rete canalis hypoglossi (not illustrated) in the canalis hypoglossi from the sinus occipitalis and the plexus venosi vertebrales interni to the end of the sinus petrosus inferior.

Vena cava superior (see Figs. 462, 478, 537, 546 and 680), unpaired, free from valves, arises behind the first right costal cartilage by the union of the *vv. anonymae dextra et sinistra* and extends downward and curved moderately convex toward the right, in front of the root of the right lung and at the right side of the aorta ascendens, to the right atrium. It is bounded in front by the thymus gland and on the right by the right lung; it is covered above on its right side by the pleura mediastinalis, below by the visceral layer of the pericardium. In the upper part of its course the *v. azygos* (see p. 474) opens into it from behind.

V. anonyma (O. T. innominate vein) (see also Figs. 478, 537 and 546) is formed behind the articulatio sternoclavicularis and in front of the a. subclavia by the union of the *v. jugularis interna*, *v. subclavia* and *v. jugularis externa;* the latter opens usually into the v. subclavia. The right vein is bounded on the right by the right lung and runs vertically downward; the left, distinctly longer, extends to the right and downward, behind the manubrium sterni and the thymus, directly over the arcus aortae, in front of the aa. subclavia sinistra, carotis communis sinistra and anonyma. Both veins are devoid of valves. Branches:

1. **Vv. thyreoideae inferiores** (inferior thyroid veins) (see Fig. 537) from the *plexus thyreoideus impar.* This lies partly in front of the lower margin of the isthmus glandulae thyreoideae, in part it surrounds the beginning of the trachea like a ring; it anastomoses with the vv. thyreoideae superiores of both sides and receives, behind, the *vv. tracheales*, the *vv. oesophageae* and the *v. laryngea inferior* (corresponding to the arteries of the same names). Three veins usually go off from the plexus: a right vein opens at the angle of junction of the vv. anonymae or into the v. anonyma dextra or into the v. jugularis interna dextra, a left vein into the v. anonyma sinistra and a middle, *v. thyreoidea ima*, running downward in front of the trachea, into the v. anonyma sinistra.

2. **V. mammaria interna** (internal mammary vein) (see Figs. 364 and 537) corresponds almost exactly to the artery of the same name. Arising from the union of the double *vv. epigastricae superiores* (rich in valves) and the *vv. musculophrenicae* it is double in the region of the m. transversus thoracis; above the latter it is single and situated medial from the artery. It receives (with the vv. musculophrenicae) the anterior extremities of the 9(—10) superior *vv. intercostales* (see p. 473), which have valves at their mouths, farther the *rami perforantes* (especially marked in the 1st or 2nd intercostal space), which have valves, as well as *rami sternales* from the networks which are situated upon both surfaces of the sternum, and in which there are several large transverse connections between the trunks of the two sides, sometimes especially one such on the anterior surface of the processus xiphoideus.

3. **Vv. phrenicae superiores** (not illustrated) possess valves, are double and correspond to the a. pericardiacophrenica.

4. **Vv. thymicae, pericardiacae, mediastinales anteriores, bronchiales anteriores** (not illustrated) from the viscera of the thorax, open separately or partially in common.

5. **V. vertebralis** (see Fig. 539) corresponds to the cervical part of the a. vertebralis, on the lateral side of which it extends downward from the foramen magnum through the foramina transversaria of the 1st—6th (often —7th) cervical vertebra. It begins in the plexus venosi vertebrales, anastomoses with the v. occipitalis and receives branches from the spinal canal, from the deep muscles of the neck and from the plexus vertebrales externi. It stands open and has valves at its mouth. Branch:

V. cervicalis profunda (see Fig. 537) corresponds approximately to the a. cervicalis profunda, begins near the back of the head in the plexus vertebralis posterior und runs downward behind or in front of the m. semispinalis cervicis; it goes forward beneath the proc. transversus of the 7th cervical vertebra into the v. vertebralis. There are valves at its mouth.

V. jugularis interna (internal jugular vein) (see also Fig. 540) corresponds together with the vv. jugulares externa and anterior to the a. carotis communis. It arises as the direct continuation of the sinus transversus in the lateral compartment of the foramen jugulare with a swelling filling up the fossa jugularis, the *bulbus v. jugularis superior*, above runs downward behind the a. carotis interna on the lateral wall of the pharynx, becomes displaced gradually to the lateral side first of the a. carotis interna, then of the a. carotis communis and extends downward, close to the latter, to the v. anonyma. A little above its termination it presents a spindle-shaped dilatation, the *bulbus v. jugularis inferior*, which is closed above by a single or double valve. Otherwise it is devoid of valves. Branches:

1. **Sinus durae matris** see pp. 459—462.

2. **V. canaliculi cochleae** (not illustrated) comes from the cochlea (see p. 856) through the canaliculus cochleae and opens into the bulbus v. jugularis superior.

3. **V. occipitalis** (see p. 468).

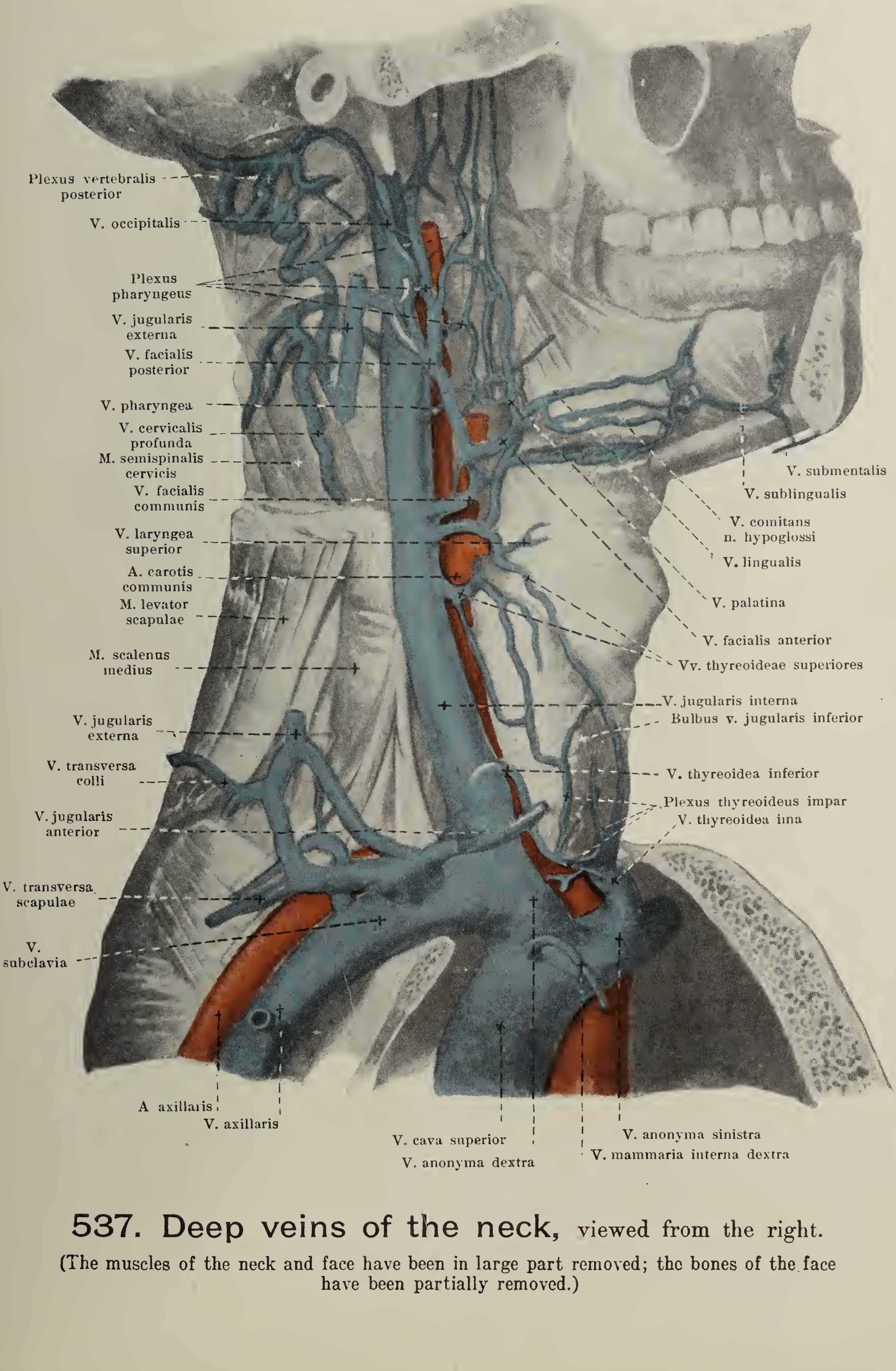
4. **Vv. pharyngeae** vary in number and come at different levels from the *plexus pharyngeus* which covers the outer surface of the pharynx and receives branches from the deep muscles of the pharynx, from the tuba auditiva, the palate and dura mater *(v. meningea*, corresponding to the a. meningea posterior), as well as the *v. canalis pterygoidei [Vidii]* (from the canalis pterygoideus); the plexus connect with the neighboring veins. The inferior vv. pharyngeae may open also into other branches of the v. jugularis interna. They are all devoid of valves.

5. **V. lingualis** (lingual vein) (see also Fig. 540) runs backward at first exactly as does the a. lingualis, later, however, on the lateral surface of the m. hypoglossus; it receives a large *v. sublingualis* and the *vv. dorsales linguae.* The a. lingualis is accompanied medially from the m. hypoglossus by small veins, which together with the *v. comitans n. hypoglossi* open into the v. lingualis. All branches possess valves; the vein communicates with the vv. pharyngeae and the v. thyreoidea superior; it opens sometimes into a v. facialis or a v. thyreoidea superior.

6. **Vv. thyreoideae superiores** (superior thyroid veins) (see also Fig. 540), usually two, accompanying the artery only in part; one opens far below, the other above, near the a. thyreoidea superior. The latter receives a *v. sternocleidomastoidea* and the *v. laryngea superior* (corresponding to the a. laryngea superior), which may also open into the v. facialis communis, and frequently opens into the v. facialis communis. These veins possess valves.

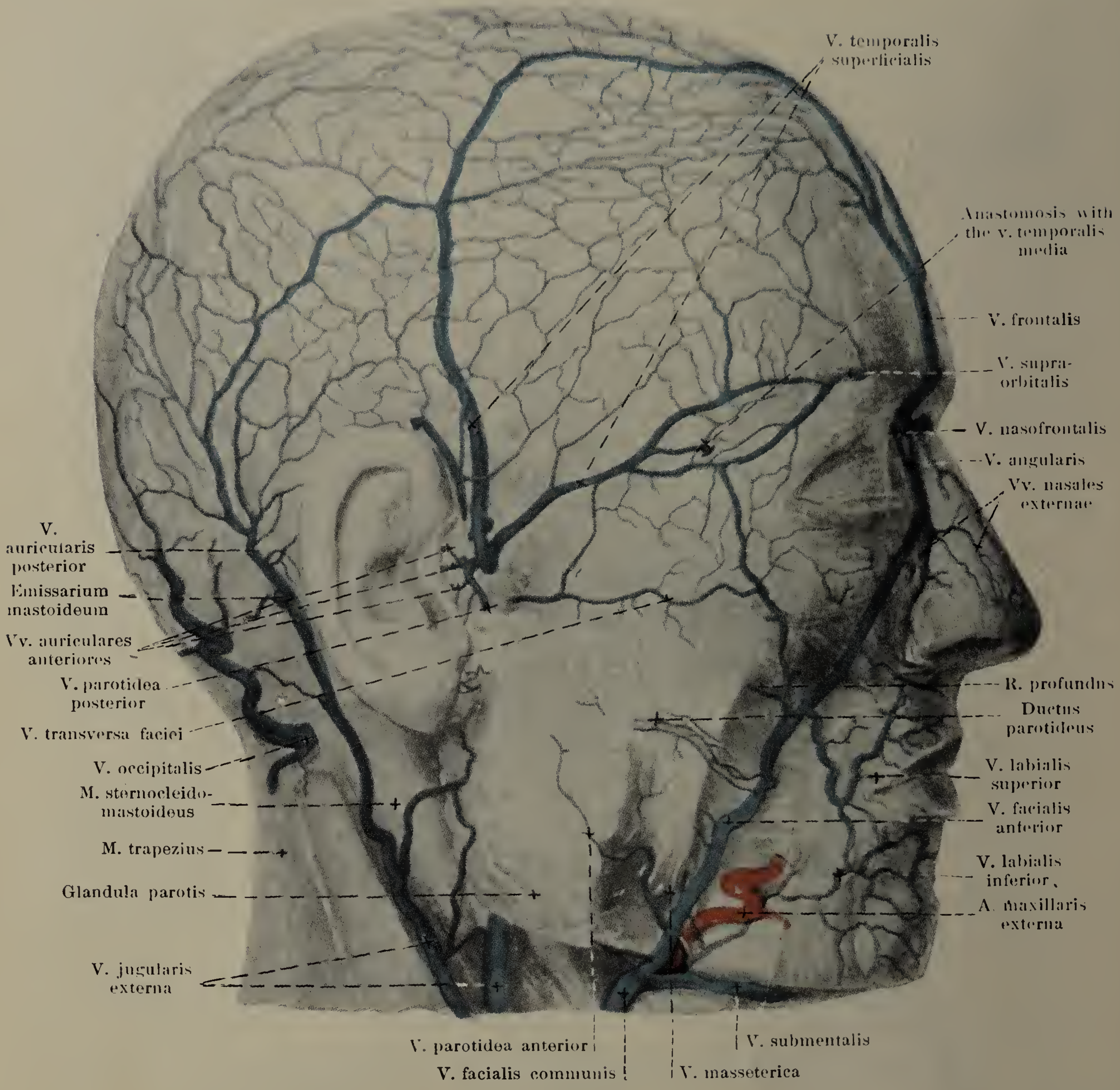
7. **V. facialis communis** (see also Figs. 539 and 540) arises beneath the angle of the lower jaw, from the *vv. faciales anterior* and *posterior*, which may also open separately into the v. jugularis interna. It runs downward and backward, covered only by the platysma, crosses the a. carotis externa and terminates at the level of the hyoid bone. It has no valves. Branches:

a) *V. facialis anterior* (see also Figs. 538—540) corresponds in its course to that of the a. maxillaris externa, which itself possesses in addition two small accompanying veins; it is a little tortuous and rnus usually behind the artery and in part more superficially, covered only by the mm. zygomaticus, risorius and platysma, from the root of the nose to the angle of the lower jaw. It arises superficially at the medial angle of the eye as the *v. angularis*, formed by the *vv. frontalis* (usually unpaired, and then very frequently opening into the left v. angularis), *supraorbitalis* (runs transversely medianward partly beneath the m. orbicularis oculi over the margo supraorbitalis, anastomoses with the vv. temporales superficialis and media) and *nasofrontalis* (see p. 460); in front of the root of the nose it forms a broad union with the vein of the other side. Above, it receives further: the *vv. palpebrales superiores*, *nasales externae*, *palpebrales inferiores* and *labialis superior*, besides the *ramus profundus;* this is formed in the fossa infratemporalis by the *vv. alveolares superiores* (coresponding to the arteries of the same name) and by branches of the plexus pterygoideus, and receives one branch of the v. ophthalmica inferior; it runs forward upon the facies infratemporalis maxillae and terminates below the arcus zygomaticus. Farther down enter the *v. labialis inferior*, *vv. massetericae* and *vv. parotideae anteriores.* Beneath the lower jaw it receives further the large *v. submentalis*, which is connected with the v. sublingualis and v. jugularis anterior, as well as one *v. palatina*, which corresponds to the a. palatina ascendens. All the branches of the vein possess efficient valves at their mouths; the main trunk also contains such valves at the level of the ductus parotideus.



537. Deep veins of the neck, viewed from the right.

(The muscles of the neck and face have been in large part removed; the bones of the face have been partially removed.)



538. Superficial veins of the face, viewed from the right.

(With partial use of a preparation by W. Braune.)

(Below the zygoma, the subcutaneous fat and a part of the muscles have been removed.)

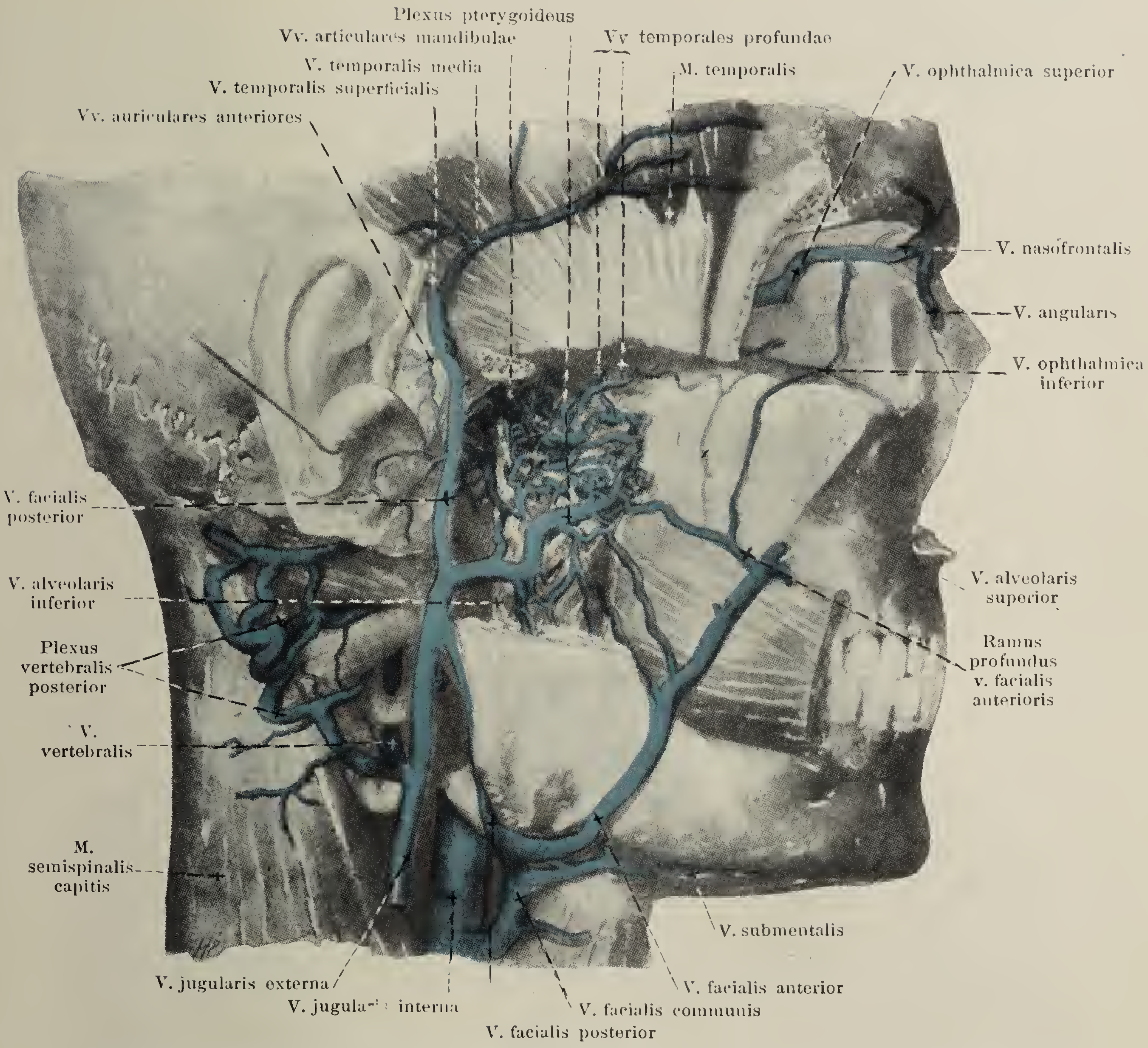
b) *V. facialis posterior* (see also Figs. 537 and 539) arises superficially in front of the ear through the union of the vv. temporales superficialis et media, runs downward in the substance of the glandula parotis behind the ramus mandibulae and lateral from the carotis externa and bends obliquely forward below the angulus mandibulae, over or under the m. digastricus, to the v. facialis communis. It gives off a large branch at a variable level to the v. jugularis externa. It receives:

ba) *V. temporalis superficialis*, from the superficial plexus of the roof of the skull, runs downward behind the trunk of the artery. It possesses a valve in front of the ear.

bb) *V. temporalis media* runs transversely backward, deviating from the artery, in the m. temporalis, anastomoses at the lateral angle of the eye with the superficial veins, in the muscle with the vv. temporales profundae and perforates the fascia temporalis over the root of the zygoma. It possesses valves.

bc) *Vv. auriculares anteriores*, from the lateral surface of the external ear.

bd) *Vv. parotideae posteriores*, from the glandula parotis.



539. Deep veins of the face, viewed from the right.

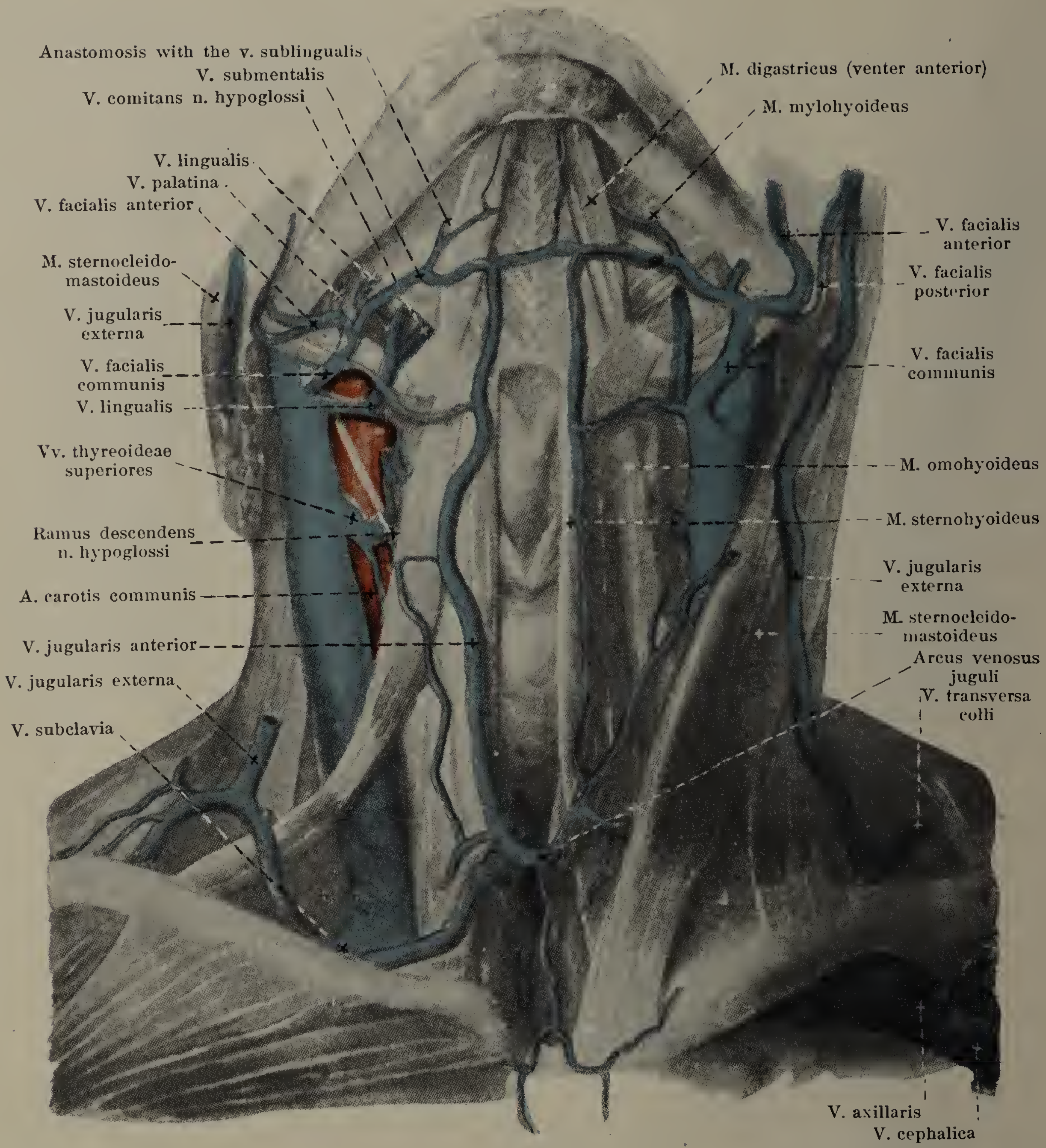
(The bones and muscles have been removed as in Fig. 489.)

be) *Vv. articulares mandibulae*, from a plexus surrounding the joint of the jaw, which also receives the *vv. tympanicae* (not illustrated) (through the fissura petrotympanica [Glaseri] from the middle ear) and veins from the external auditory passage and eardrum membrane and is connected with the plexus pterygoideus.

bf) *V. stylomastoidea* (not illustrated), corresponding to the artery of the same name, anastomoses at the hiatus canalis facialis with the vv. meningeae mediae.

bg) *V. transversa faciei* (transverse facial vein), frequently double, corresponds to the artery of the same name.

bh) *Plexus pterygoideus* extends from the fossa pterygopalatina as far as the collum mandibulae and lies, with wider vessels, on both sides of the m. pterygoideus externus, with narrower vessels, also on the medial surface of the m. pterygoideus internus and on the membranous wall of the tuba auditiva; it forms a sheath for the a. maxillaris interna, whose branching area corresponds to its inlets. It receives: the *v. sphenopalatina* (from the nasal cavity through the foramen sphenopalatinum), the *vv. meningeae mediae* (see p. 462), the *vv. temporales profundae* (from the m. temporalis, in which it forms a plexus with branches of the v. temporalis media), branches from the maxilla, the *vv. massetericae, v. alveolaris inferior* (the latter two corresponding to the arteries of the same names) and the *rete foraminis ovalis* (see p. 463). It anastomoses with the vv. articulares mandibulae and with the plexus pharyngeus and empties in part through the ramus profundus v. facialis anterioris, especially however through one or two valve-bearing vessels, which accompany the a. maxillaris interna, into the v. facialis posterior.



540. Veins of the neck, viewed from in front.

(On the right the m. sternocleidomastoideus, on the left the m. pectoralis major, has been removed.)

V. jugularis externa (external jugular vein) (see also Figs. 537—539) arises below the ear by two roots: the anterior, frequently the larger, comes from the v. facialis posterior (see p. 466), the posterior arises behind the ear. It crosses the m. sternocleidomastoideus at a sharp angle, covered by the platysma, goes above the clavicula into the depth and opens usually into the v. subclavia, generally with the v. jugularis anterior. Valves at its mouth and in its middle. Branches:

1. **V. occipitalis** corresponds to the a. occipitalis. It opens partly into the v. jugularis externa, partly, doubled, accompanies the a. occipitalis to the v. jugularis interna; it anastomoses with the v. vertebralis and the plexus vertebralis posterior.
2. **V. auricularis posterior** from the superficial plexus behind the ear.
3. **V. jugularis anterior,** downward from the chin upon the mm. mylohyoideus and sternohyoideus, extends lateralward below the origins of the m. sternocleidomastoideus to the v. jugularis externa or the v. subclavia. It anastomoses with the adjacent veins, and, by the large *arcus venosus juguli,* below the glandula thyreoidea with the vein of the opposite side. More rarely instead of this vein only an unpaired median trunk *(v. mediana colli)* is present.

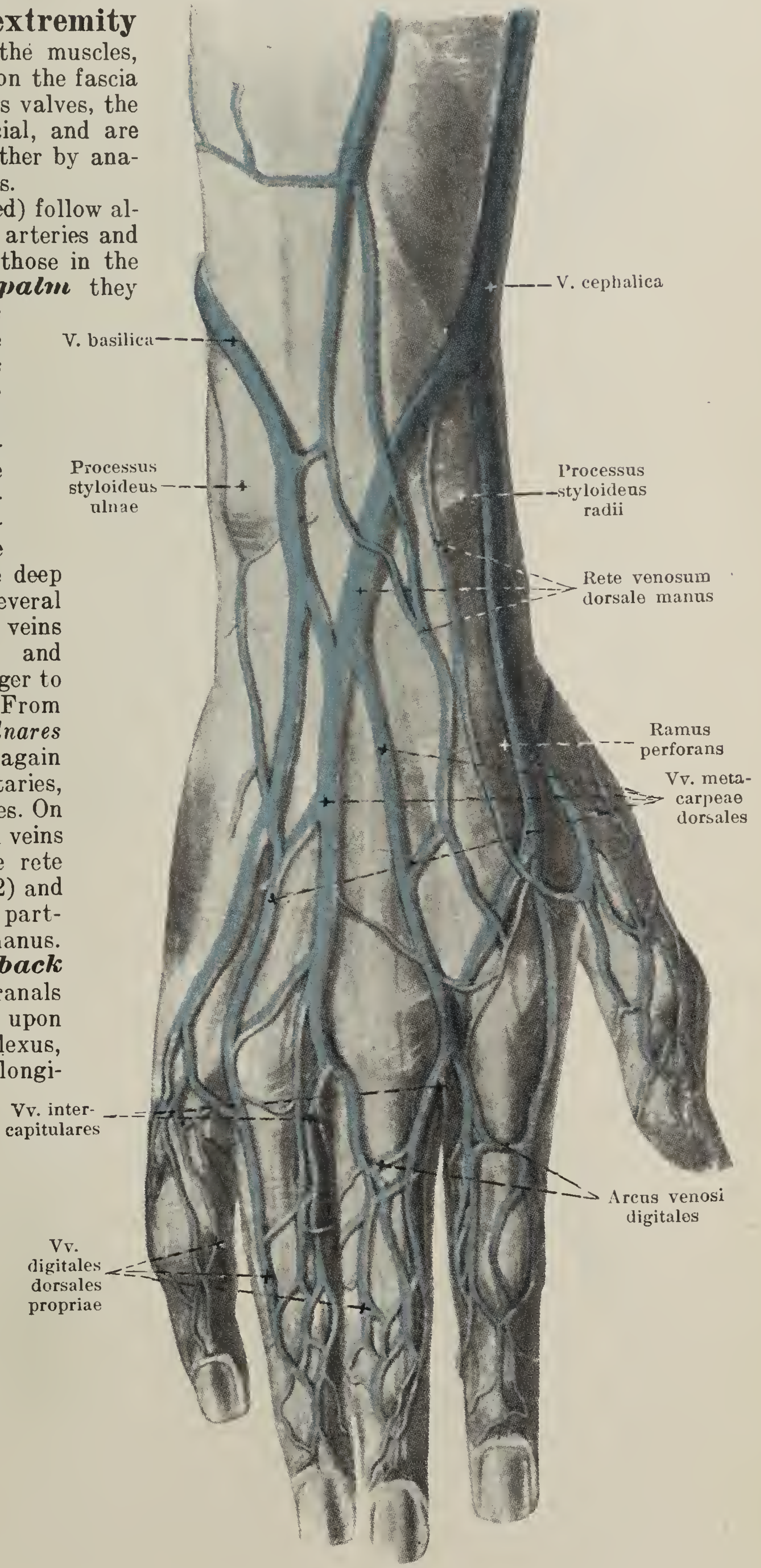
541. Superficial veins of the back of the right hand.

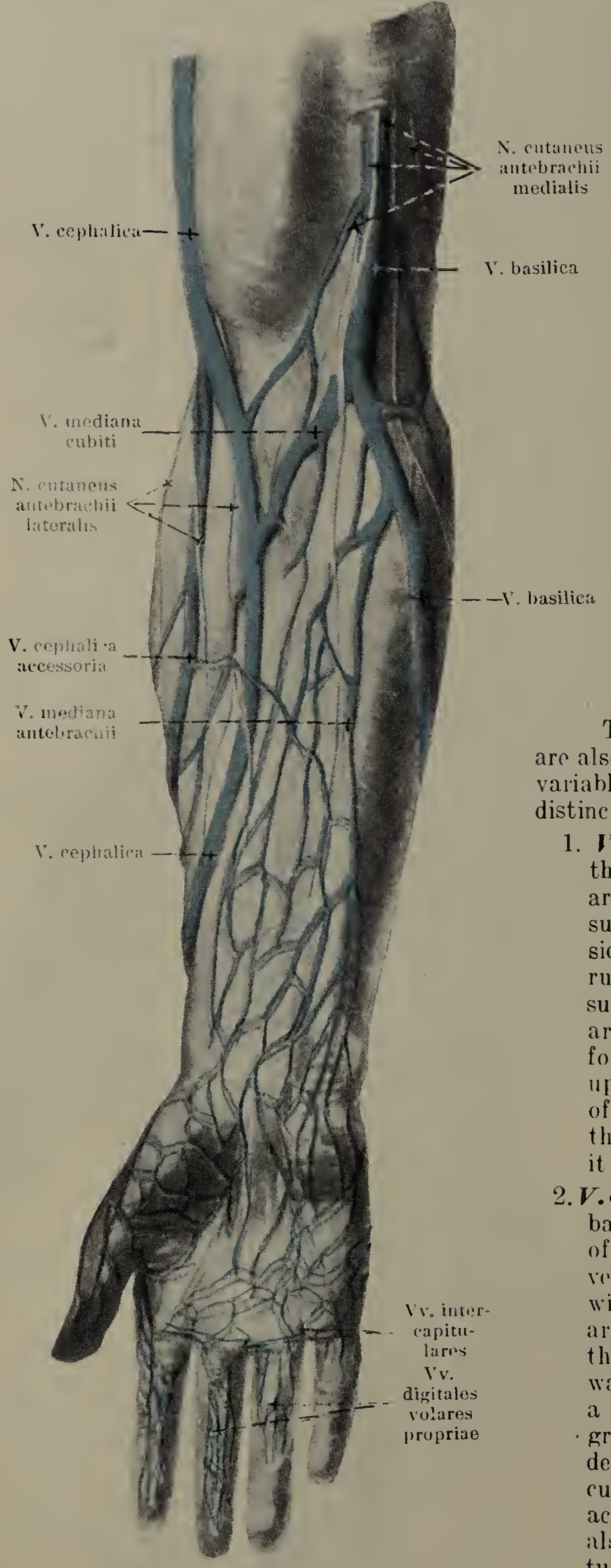
(Partly after W. Braune.)

The **veins of the upper extremity** run partly in the depth between the muscles, partly in plexuses, superficially, upon the fascia superficialis. Both possess numerous valves, the deep veins more than the superficial, and are manifoldly connected with one another by anastomoses, which are devoid of valves.

The **deep veins** (not illustrated) follow almost exclusively the corresponding arteries and are double, with the exception of those in the fingers and in the axilla. In the ***palm*** they begin as single *vv. digitales volares propriae* (see Fig. 542), which unite to form the *vv. digitales volares communes* and go into the double *arcus volaris venosus superficialis.* In the depth run the *vv. metacarpeae volares*, which open into the double *arcus volaris venosus profundus;* they send in addition several *rami perforantes* through the spatia interossea metacarpi to the deep veins of the back of the hand, several smaller and regularly two larger veins into the 1st metacarpal space and through the muscles of the little finger to the rete venosum dorsale manus. From the palmar arches arise the *vv. ulnares* and *vv. radiales* and from these again the *vv. brachiales* with their tributaries, corresponding exactly to the arteries. On the ***back of the hand*** deep, small veins accompany the deep layer of the rete (arteriosum) carpi dorsale (see p. 432) and empty partly into the vv. radiales, partly into the rete venosum dorsale manus.

The **superficial veins *of the back of the hand*** represent the chief canals of outflow for the skin. They begin upon the phalanges of the fingers in a plexus, which permits of the recognition of longitudinal trunks, *vv. digitales dorsales propriae*, and each terminates on the first phalanx in the *arcus venosus digitalis* which is concave proximalward. From the union of every pair of these arches, arise larger *vv. metacarpeae dorsales* (originally four); these open in a very variable manner in a distal convex *arcus venosus dorsalis manus*, the position of which corresponds to about the middle of the ossa metacarpalia, or they form the *rete venosum dorsale manus,* the meshes of which are elongated in the direction of the long axis of the limb.


V. cephalica
V. basilica
Processus styloideus ulnae
Processus styloideus radii
Rete venosum dorsale manus
Ramus perforans
Vv. metacarpeae dorsales
Vv. intercapitulares
Arcus venosi digitales
Vv. digitales dorsales propriae



542. Superficial veins of the right forearm,

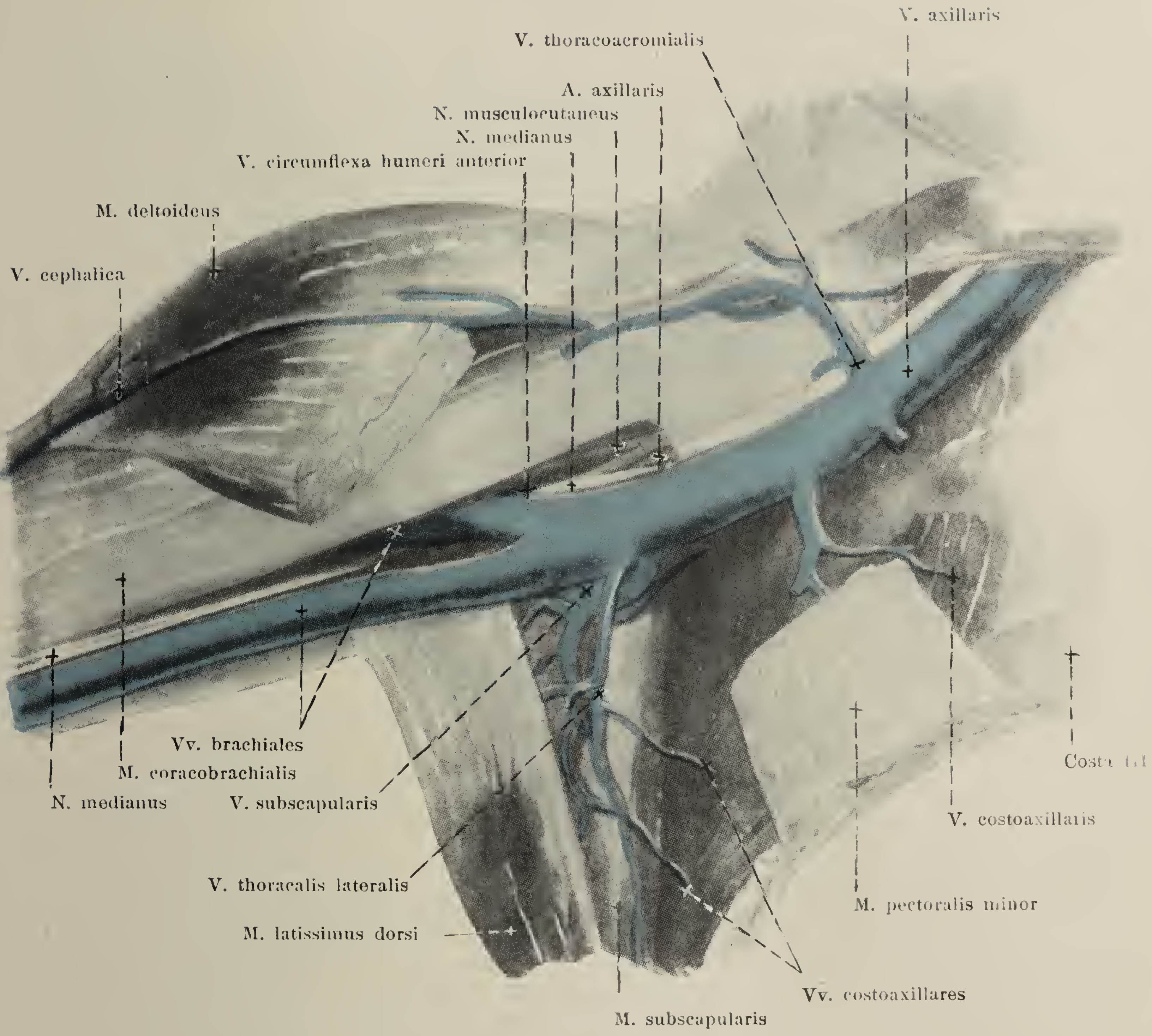
viewed from in front.

(Palm after W. Braune.)

The **superficial veins *of the palm*** are much finer than those of the back of the hand. They begin upon the phalanges in a plexus in which one can make out more or less distinctly the *vv. digitales volares propriae* and out of which most of the blood is conducted to the posterior surface through several vessels at the lateral margins of the fingers. Similarly the *vv. intercapitulares* (see also Figs. 541) conduct blood in the spaces between the fingers from the volar to the dorsal vessels. The superficial network of the palm lies upon the aponeurosis palmaris and upon the fascia of the thenar and hypothenar eminences; in the latter two places the network is somewhat closer. Proximalward it goes into the beginning of the v. mediana antebrachii.

The **superficial veins *of the forearm*** are also arranged in the form of a plexus and very variable. Among them three are usually very distinct (see also Figs. 864 and 865):

1. ***V. basilica*** (see also Fig. 541) begins upon the back of the hand, at the ulnar end of the arcus venosus dorsalis or at the rete venosum dorsale manus, loops around the ulnar side of the forearm to its volar surface and runs on this as far as the elbow, then in the sulcus bicipitalis medialis along the upper arm as far as its middle third. There it perforates the fascia, goes still some distance upward and unites sooner or later with one of the (more delicate) vv. brachiales. On the forearm it is thinner, on the upper arm it is thicker than the v. cephalica.
2. ***V. cephalica*** (see also Fig. 541) arises on the back of the hand, mostly from the radial end of the arcus venosus dorsalis or from the rete venosum dorsale manus, crosses the tabatière, winds around the radial side of the forearm to its volar surface and extends on this as far as the elbow; thence it goes upward in the sulcus bicipitalis lateralis and (in a duplicature of the fascia brachii) in the groove between the mm. pectoralis major and deltoideus, sinks into the fossa infraclavicularis and after union with a v. thoracoacromialis empties into the v. axillaris (see also Fig. 543). Usually a second longitudinal vessel is situated radially on the forearm, the *v. cephalica accessoria*, which opens into the main vein.

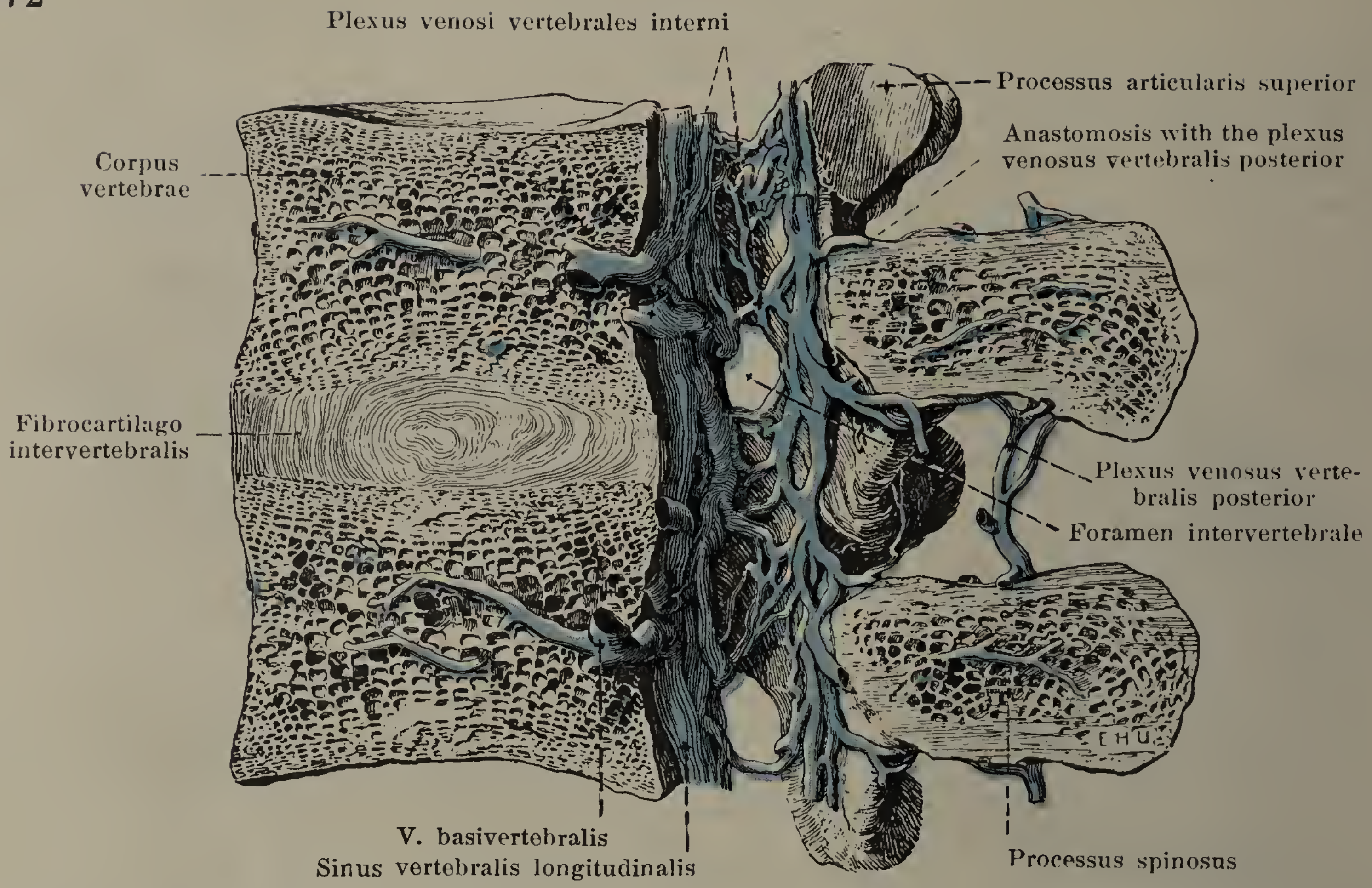


543: Veins of the right axilla, viewed from in front.

(Arrangement as in Fig. 502.)

3. ***V. mediana antebrachii*** (see Fig. 542), smaller than the vv. basilica and cephalica, originates from the superficial network of the hollow of the hand, extends on the ulnar side of the volar surface of the lower arm to the region of the elbow and opens for the most part into the v. basilica, more rarely into the v. mediana cubiti. Occasionally it bifurcates and runs partly to the v. basilica as *v. mediana basilica,* and partly to the v. cephalica as *v. mediana cephalica.* In the flexure of the elbow more frequently the *v. mediana cubiti* (see Fig. 542) leads as a connecting branch, from the v. cephalica in front of the lacertus fibrosus obliquely proximalward to the v. basilica; not seldom it conducts the main mass of the blood of the v. cephalica to the v. basilica. In both cases the superficial vessels laterally from the lacertus fibrosus anastomose freely through a valveless vessel with the deep veins.

V. axillaris *(axillary vein)* (see also Fig. 537) arises usually at the lower margin of the m. pectoralis major by the union of the two vv. brachiales and extends as far as the clavicle on the medial and anterior (superficial) surface of the artery, which is also accompanied directly by small veins. Its branches correspond to those of the artery. The ***v. thoracalis lateralis*** receives the ***v. thoracoepigastrica*** (see Fig. 555 and p. 484), which extends subcutaneously upward from the v. femoralis or from the v. epigastrica superficialis on the anterior and lateral surface of the trunk. Into this or into the neighboring veins empty the ***vv. costoaxillares*** which, in the upper 6—7 intercostal spaces, carry the blood from the middle portions of the vv. intercostales (see p. 473) to the axilla. The v. axillaris and its branches are richly provided with valves.

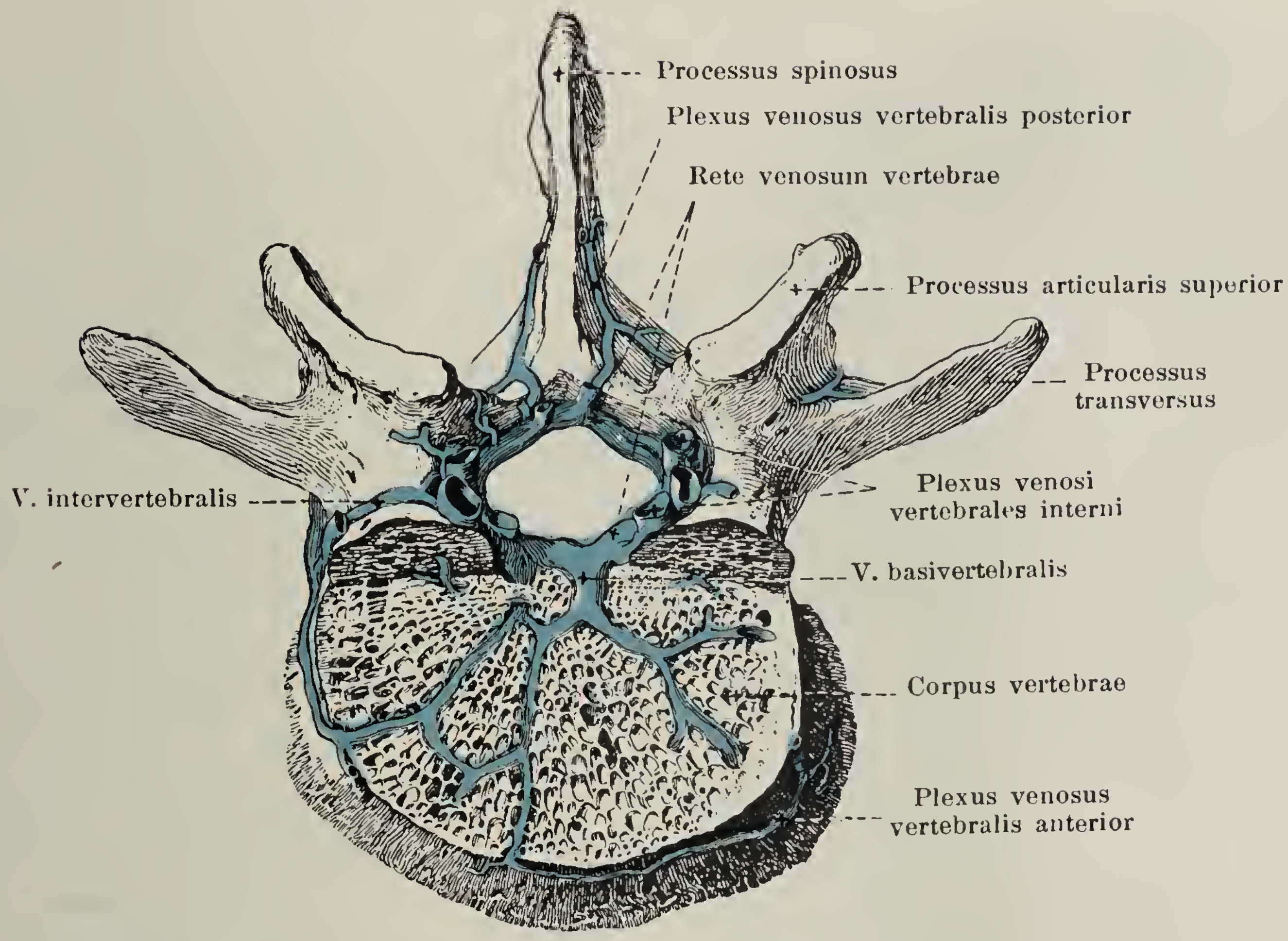

Plexus venosi vertebrales interni
Processus articularis superior
Anastomosis with the plexus venosus vertebralis posterior
Corpus vertebrae
Fibrocartilago intervertebralis
Plexus venosus vertebralis posterior
Foramen intervertebrale
E H U
V. basivertebralis
Sinus vertebralis longitudinalis
Processus spinosus

544. **Spinal veins,** seen in a median section, viewed from the left.

V. subclavia *(subclavian vein)* (see Fig. 537) is the name of the continuation of the v. axillaris from the lower margin of the m. subclavius on. It accompanies the a. subclavia on its anterior and inferior surface and crosses the first rib in front of the m. scalenus anterior. Behind the articulatio sternoclavicularis it helps to form the v. anonyma. It has valves at its beginning and at its termination. In addition to it some small veins directly accompany the a. subclavia. Tributaries (besides the v. jugularis externa):

1. and 2. **V. transversa scapulae** and **v. transversa colli** (see Figs. 537 and 540), near the corresponding arteries, unite usually to form one stem, which frequently opens into the v. jugularis externa. They carry valves at their mouths.

Veins of the spinal column. In the canalis vertebralis, between the dura mater spinalis, the periosteum and the ligaments of the canal, lie close venous plexuses, ***plexus venosi vertebrales interni,*** the tributaries of which come partly from the vertebrae, partly from the spinal cord. These plexuses have no valves and (see also Fig. 545), extend chiefly in the longitudinal direction from the foramen occipitale magnum to almost as far as the tip of the sacrum and permit the recognition of four trunks, two anterior and two posterior. The *anterior* lie upon the posterior surface of the bodies of the vertebrae and of the intervertebral disks on each side lateral from the lig. longitudinale posterius; they consist of several large veins, running very close together, which anastomose manyfoldly with one another, possess a lumen which stands open especially in the cervical and thoracic part and are accordingly also called the *sinus vertebrales longitudinales.* The *posterior* plexuses are situated on both sides on the anterior surface of the arcus vertebrarum and of the ligamenta flava and anastomose through spaces in the latter with the plexus (externi) posteriores; they are more delicate and less numerous and form more irregular, wider networks. The anterior plexuses are united with one another on the posterior surface of each vertebral body by transverse trunks, which run between the periosteum and the lig. longitudinale posterius and there receive the *vv. basivertebrales.* The latter (see also Fig. 545) extend radially in the vertebral body toward the middle of the posterior surface and open in common or separately, being provided at the mouth with valves; in front they anastomose through the bones with the plexus (externi) anteriores. The posterior plexuses are connected with one another by branches arranged in the form of a network; with the anterior they are connected by numerous shorter vessels which are present especially on the medial side of each radix arcus vertebrae and leave free only the upper part of the foramen intervertebrale. Through the connecting branches of the different plexuses with one another arise the more or less distinct vascular rings, *retia venosa vertebrarum,* one at the level of each vertebra. The upper end of the plexuses surrounds the foramen occipitale magnum like a wreath (see Fig. 535), is connected with the sinus occipitalis, plexus basilaris and rete canalis hypoglossi and empties into the vv. vertebrales. In the canalis sacralis the vessels become smaller, the plexuses become looser and empty through the foramina sacralia into the vv. sacrales.


Processus spinosus
Plexus venosus vertebralis posterior
Rete venosum vertebrae
Processus articularis superior
Processus transversus
V. intervertebralis
Plexus venosi vertebrales interni
V. basivertebralis
Corpus vertebrae
Plexus venosus vertebralis anterior

545. Spinal veins in a horizontal section, viewed from above.

(Only the body of the vertebra has been cut through.)

Plexus venosi vertebrales externi (see also Fig. 544) lie on the external surface of the spinal column, have no valves and are divisible into anterior, smaller plexuses and posterior, larger plexuses. The *plexus venosi vertebrales anteriores* are best developed in the cervical spine and there lie upon the bodies of the vertebrae and upon the mm. longi capitis et colli; they receive tributaries from the muscles and from the bodies of the vertebrae and are connected lateralward with the vv. intervertebrales and with the following plexuses. The *plexus venosi vertebrales posteriores* lie in part directly upon the posterior surface of the vertebral arches, processes and ligaments, in part between the short muscles of the back. They are best developed in the cervical portion (see also Figs. 537 and 539) and are connected there especially with the vv. occipitales, vv. vertebrales and vv. cervicales profundae; besides, they anastomose through spaces in the ligamenta flava with the plexus interni and unite in front with the plexus (externi) anteriores, with the vv. intervertebrales and with the vv. intercostales.

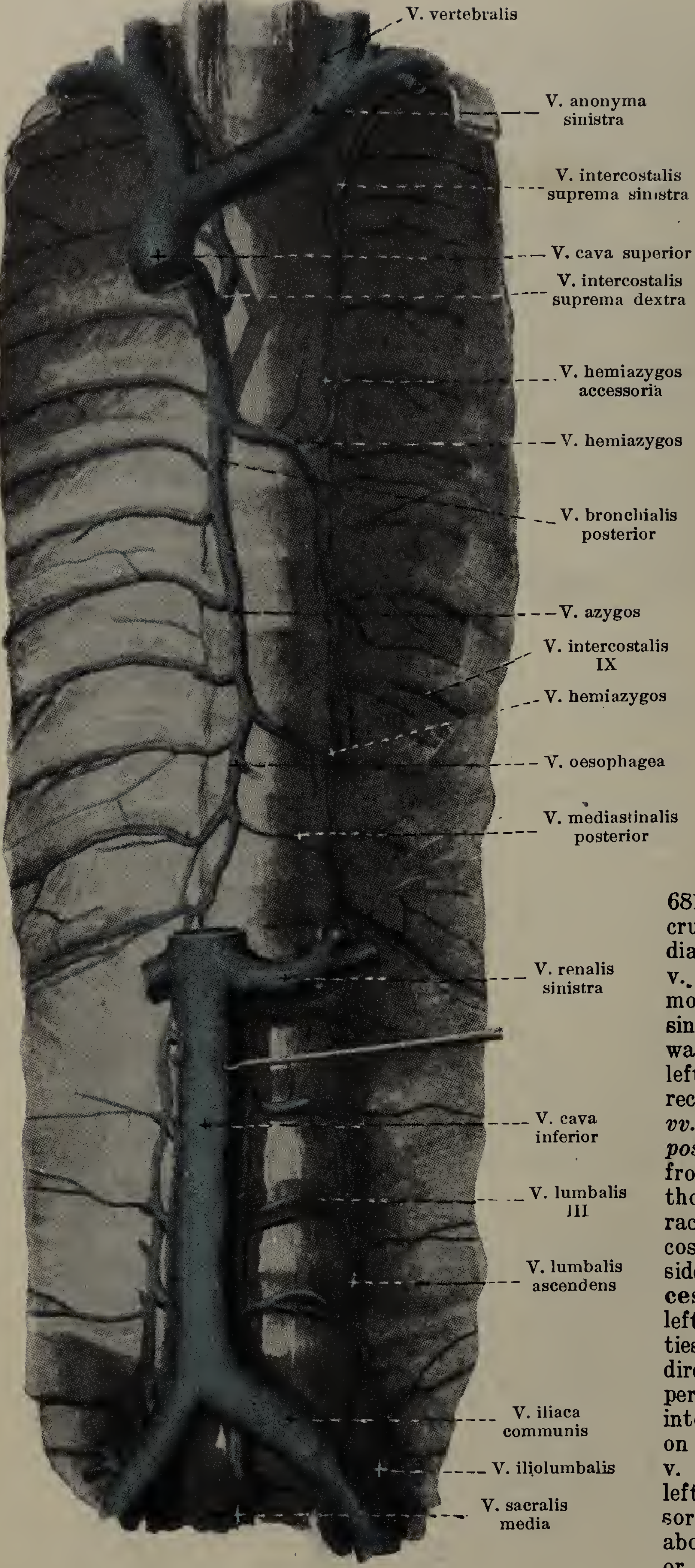
Vv. intervertebrales accompany the nn. spinales in the foramina intervertebralia and lie chiefly in plexuses on their anterior surfaces. They receive the *vv. spinales* of the spinal cord, which bear valves at their openings, and are connected with the plexus vertebrales interni and externi representing their channels of outflow; they have valves where they terminate in the neck in the v. vertebralis, or in the trunk in the vv. intercostales (vide infra), lumbales or sacrales laterales.

The **vv. intercostales** (see Fig. 546), situated usually singly at the lower margin of a rib in the sulcus costae, close to and above the artery, increase evenly in diameter from above downward. The upper 9 (—10) form venous circles which empty their contents partly sternalward into the vv. mammaria interna and musculophrenicae (see p. 463), partly vertebralward into the system of the v. azyos; at their mouths they carry valves correspondingly directed; from their middle portions they send off branches in the 1st—6th (or 7th) intercostal space to the axilla *(vv. costoaxillares,* see p. 471). The lower 2—3 vv. intercostales have no outflow forward and receive tributaries, supplied with valves, from the diaphragm and from the abdominal muscles. Veins of smaller diameter and inconstant in length are to be found also at the upper margin of each rib; they are manifoldly connected with the others. Each v. intercostalis unites with a *ramus posterior* near the bodies of the vertebrae, which is larger than it is itself and which runs near the ramus posterior of the a. intercostalis; into this flow tributary vessels from the skin and from the muscles of the back, as well as the *ramus spinalis,* which, as a continuation of the vv. intervertebrales (vide supra), collects the blood from the spinal column and its contents.

546. Vena azygos,

viewed from in front.

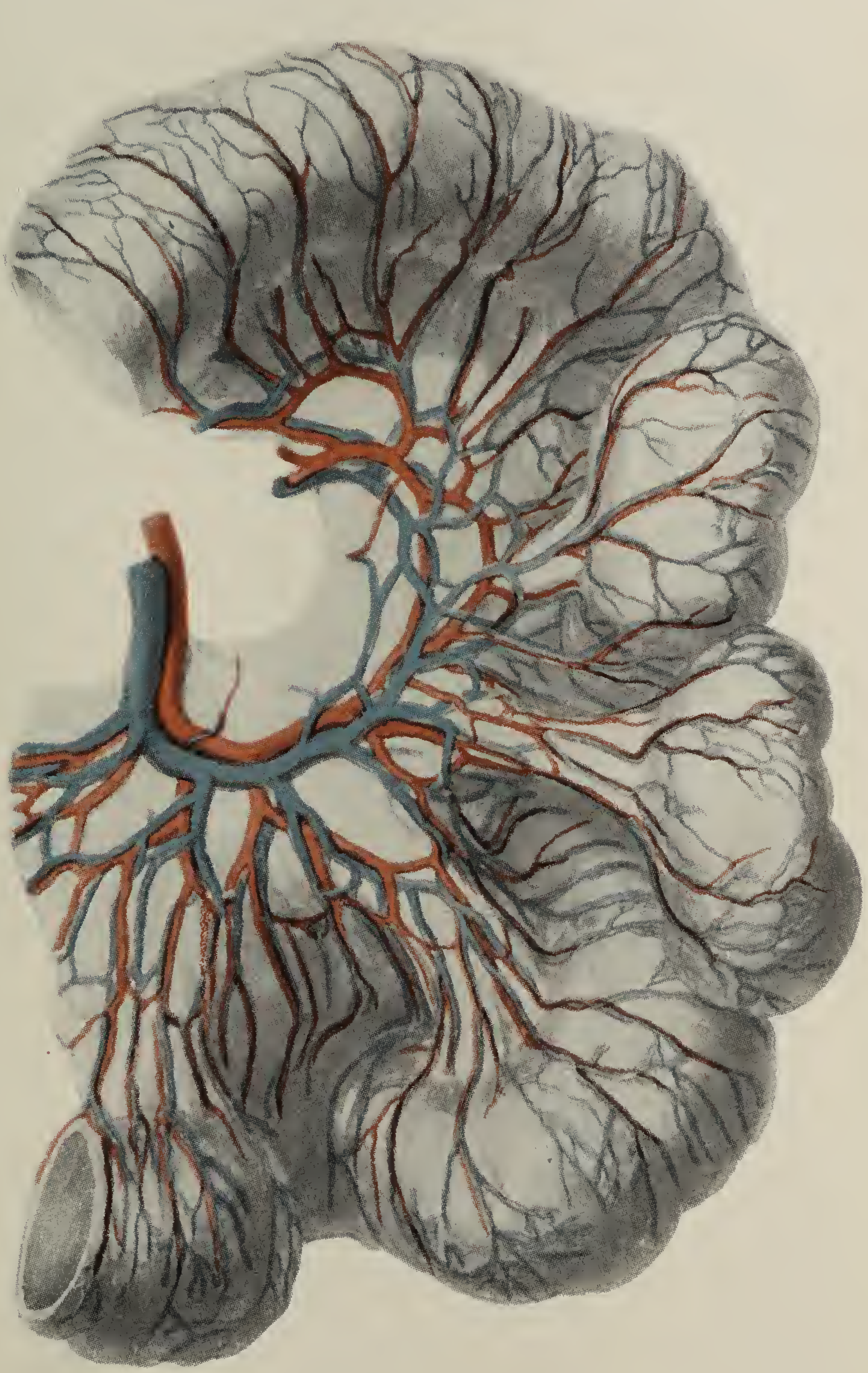
(The diaphragm, the right mm. intercostales interni and the lumbar muscles have been removed.)



V. azygos, unpaired, begins as a continuation of the v. lumbalis ascendens dextra (see p. 478) between the right crus mediale and crus intermedium of the diaphragm, ascends in the spatium mediastinale posterius on the right or anterior side of the vertebral bodies, and in its course lies in front of the aa. intercostales dextrae, to the right of the aorta thoracalis and of the ductus thoracicus and behind the oesophagus. At the level of the 5th or 4th thoracic vertebra it bends forward over the root of the right lung and opens into the v. cava superior (see also Figs. 478 and 680). In this latter portion of its course it usually possesses valves, which, however, are not efficient. It anastomoses sometimes at the beginning with the v. renalis dextra, receives the nine lowermost vv. intercostales dextrae, as well as the *vv. oesophageae*, *vv. bronchiales posteriores* and *vv. mediastinales posteriores* (from the corresponding organs) (not illustrated), besides the **v. hemiazygos.** The latter (see also Fig. 681) begins, unpaired, between the left crus mediale and crus intermedium of the diaphragm as the continuation of the v. lumbalis ascendens sinistra, but is in most cases connected with the v. renalis sinistra. Devoid of valves, it extends upward, behind the aorta thoracalis, on the left side of the bodies of the vertebrae, receives several vv. intercostales sinistrae, *vv. oesophageae* and *vv. mediastinales posteriores*, and bends to the right in front of one of the inferior or middle thoracic vertebrae behind the ductus thoracicus to go to the v. azygos. The intercostal veins, next higher up on the left side, empty into a **v. hemiazygos accessoria,** which goes downward on the left side of the thoracic spine and empties either into the v. hemiazygos or directly into the v. azygos. The 3—4 upper intercostal veins open on each side into a *v. intercostalis suprema*, which on the right side usually opens into the v. azygos (supplied with valves), on the left side into the v. hemiazygos accessoria, but in addition also communicates above on each side with the v. anonyma or with the v. vertebralis.

547.

Arteries and veins of a piece of small intestine.

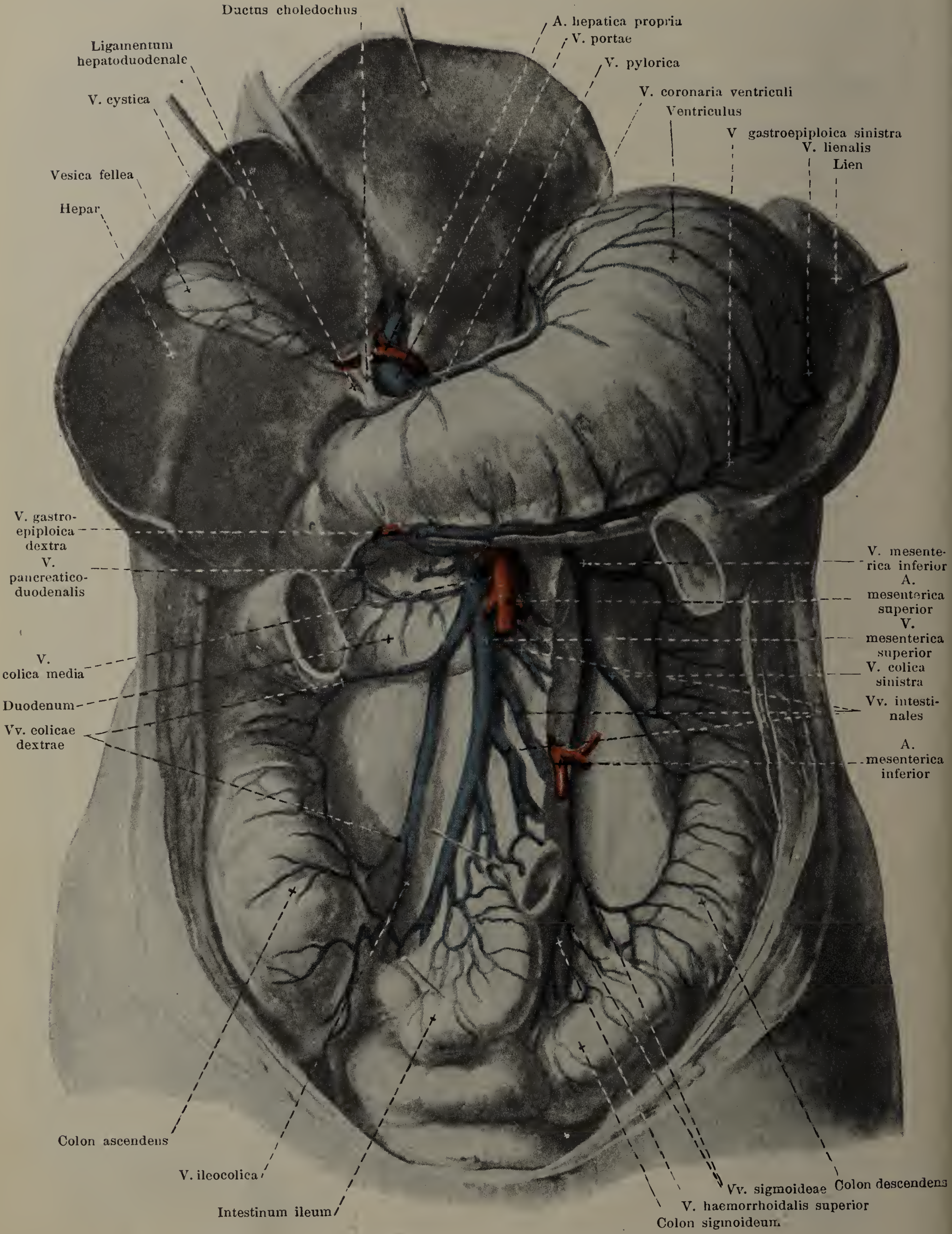


The **vena portae** *(portal vein)* (see Fig. 548 and 549) collects the blood from the whole digestive tube, from the cardia on as far as the m. levator ani, from the pancreas, the gall bladder and the spleen. Its *trunk* arises behind the caput pancreatis, on the left and posterior surface of the pars superior duodeni, from the union of the v. mesenterica superior and the v. lienalis; it is 2—3 cm long and runs upward in the lig. hepatoduodenale, behind the a. hepatica and the hepatic and biliary ducts, to the porta hepatis; there it divides into a right and a left branch one for each half of the liver. Its *roots* follow, in general, the branches of the arteries of the same name and are supplied with valves only in their finer subdivisions immediately after their exit from the wall of the stomach and intestine.

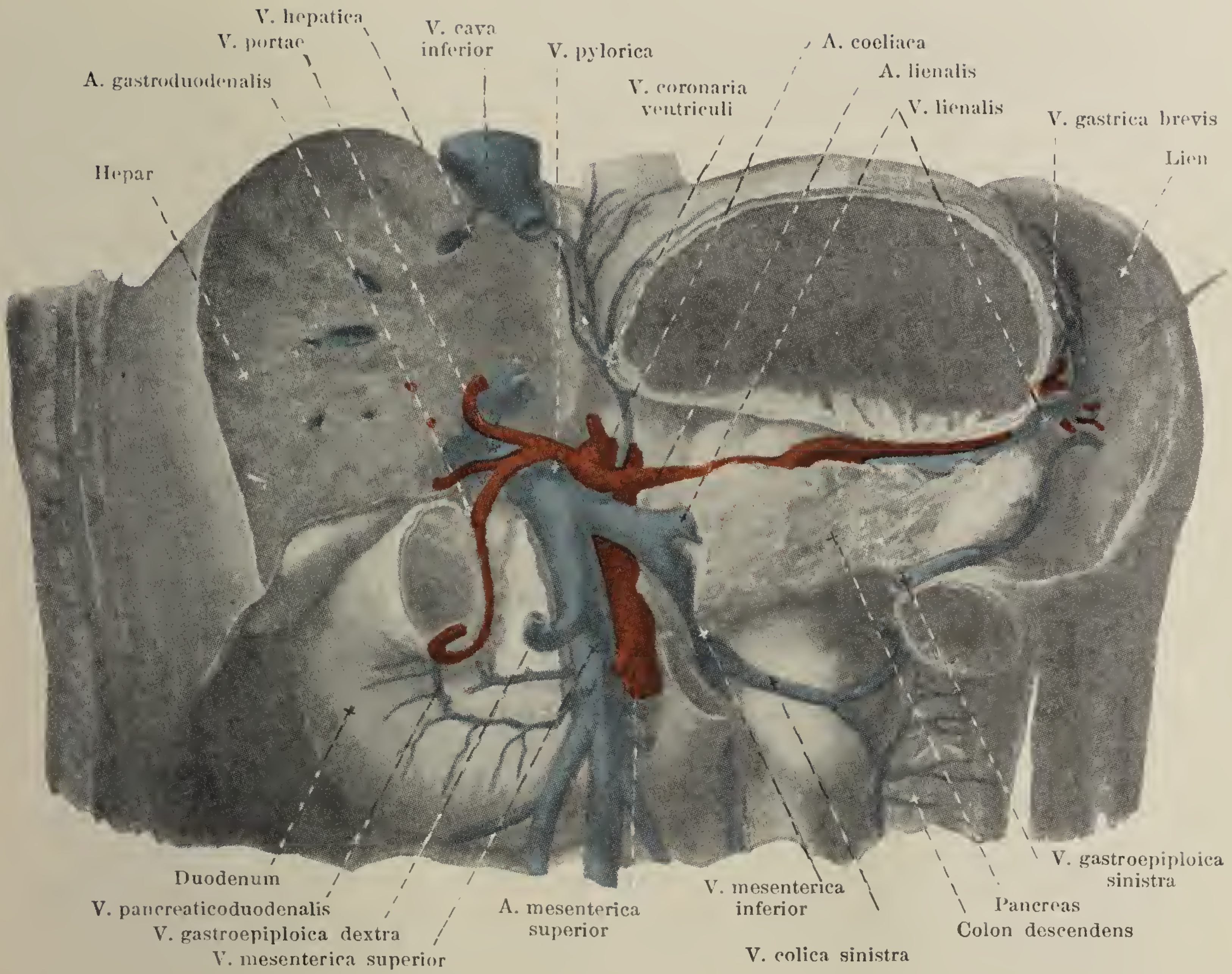
1. **V. mesenterica superior** (see Figs. 548 and 549) runs on the right side of the a. mesenterica superior, arises from numerous *vv. intestinales* (from the small intestines), from the *v. ileocolica, vv. colicae dextrae, v. pancreaticoduodenalis, vv. duodenales, vv. pancreaticae, v. colica media* and *v. gastroepiploica dextra.* The intestinal veins anastomose with one another very much as the arteries do but more frequently.

2. **V. mesenterica inferior** (see Figs. 548 and 549) collects its blood from the *v. haemorrhoidalis superior* (see also p. 482), the *vv. sigmoideae* and the *v. colica sinistra.* Its peripheral course agrees with that of the a. mesenterica inferior; its trunk however separates from this and goes in a curved direction upward and to the right behind the peritonaeum (frequently in the plica duodenojejunalis) and behind the pancreas; it usually opens into the v. lienalis, frequently into the v. mesenterica superior, sometimes at the point of junction of the two.

3. **V. lienalis** (see Figs. 548 and 549) is formed by the union of the veins of the spleen with the *v. gastroepiploica sinistra* and with the *vv. gastricae breves;* it runs from the left to the right beneath the a. lienalis and behind the pancreas, and in its course receives several pancreatic veins. It crosses the aorta between the a. coeliaca and the a. mesenterica superior.



548. Tributaries of the portal vein.
(The transverse colon and the small intestines have been partially removed; the liver has been drawn upward.)



549. Trunk of the portal vein.

(The stomach, liver and pancreas have been partially, the small intestines and the transverse colon completely, removed.)

4. **V. coronaria ventriculi** (see also Fig. 548) runs from the right to the left along the curvatura minor of the stomach, anastomoses near the pylorus with the v. pylorica, at the cardia with the oesophageal veins and opens near the a. gastrica sinistra into the trunk of the v. portae or the v. lienalis.

5. **V. pylorica** (see also Fig. 548), more delicate than the preceding, extends from the left to the right near the a. gastrica at the curvatura minor of the stomach, anastomoses with the preceding vein and opens at the pylorus into the stem of v. portae.

6. **V. cystica** (see Fig. 548) from the gall bladder, opens into the stem or the right branch of the portal vein.

The **accessory portal veins** (not illustrated) are small vessels, which arise in the folds of the peritonaeum connecting with the liver, or which come especially from the stomach and pass either into the stem of the portal vein or directly into the substance of the liver.

The **anastomoses of the portal** with the vv. cavae are regularly present as follows:

1) At the cardia of the stomach between the v. coronaria ventriculi (v. portae) and the oesophageal veins (v. azygos);
2) at the rectum in the plexus haemorrhoidales between the v. haemorrhoidalis superior (v. mesenterica inferior) and the vv. haemorrhoidales mediae et inferiores (vv. hypogastricae). Valves usually prevent a flow back from the v. hypogastrica to the v. portae.
3) *vv. parumbilicales [Sappeyi]* (not illustrated), 4—5 small vessels, which are connected in the neighborhood of the navel with the superficial veins and with the vv. epigastricae inferiores, extend near the lig. teres hepatis to the liver and empty usually directly into its substance. The largest anastomoses also with the left v. epigastrica superior. One of these veins is said to be the remains of the v. umbilicalis. They are supplied with valves; the current is directed toward the liver.

V. cava inferior (see also Fig. 686) arises by the union of the vv. iliacae communes in front of the intervertebral disk between the 4th and 5th lumbar vertebra behind the first portion of the a. iliaca communis dextra somewhat to the right of the median plane. From there on, it ascends at first in front of the bodies of the lumbar vertebrae and in front of the origins of the right m. psoas major, then in front of the a. renalis dextra and in front of the right crura diaphragmatis and at the same time somewhat to the right and forward, goes through the foramen venae cavae of the diaphragm and, curved somewhat forward, opens into the right atrium of the heart. In its course it lies on the right side of the aorta abdominalis and is covered in front by the peritonaeum, by the pars inferior duodeni and by the caput pancreatis; above, it is embedded in the fossa venae cavae of the liver and firmly fused with it, so that only its posterior wall lies partly free (see Fig. 632). It is devoid of valves. Its branches are divisible into *radices parietales* (from the walls of the peritoneal cavity) and *radices viscerales* (from the abdominal viscera).

A. ***Radices parietales;***

1. **V. phrenica inferior,** paired, partly double, corresponds to the a. phrenica inferior and opens at the foramen venae cavae.

2. **Vv. lumbales** (see also Figs. 546 and 551), on each side 4—5, run close to and over the aa. lumbales, correspond to the vv. intercostales (see p. 473) and receive tributaries from the muscles and from the skin of the back, from the plexuses of the spine and from the abdominal muscles. They possess (insufficient) valves, run medianward upon the lateral and anterior surface of the bodies of the vertebrae (those of the left side behind the aorta) and open into the posterior wall of the v. cava. The vv. lumbales are united on each side with one another by means of longitudinal anastomoses which are situated behind the m. psoas major in front of the roots of the procc. transversi. The sum of these anastomoses forms on each side a vessel running vertically, the *v. lumbalis ascendens,* which is connected below with the v. iliolumbalis and frequently with the v. iliaca communis, above however is continued on the right side directly into the v. azygos, on the left side into the v. hemiazygos (see p. 474).

B. ***Radices viscerales:***

1. **Vv. hepaticae** (see also Fig. 631), 2—3 large trunks, collect the blood which is led to the capillary system of the liver through the a. hepatica propria and v. portae; they leave the liver in the uppermost part of the fossa venae cavae and open into the v. cava just below the diaphragm. The right v. hepatica, largest, carries the blood from the right lobe of the liver, the middle, smallest, vein from the lobi caudatus [Spigeli] and quadratus, the left from the left lobe of the liver. Several small vv. hepaticae open in the fossa venae cavae, below the large ones, directly into the v. cava inferior. Valves are only rarely present at the mouths of the large veins.

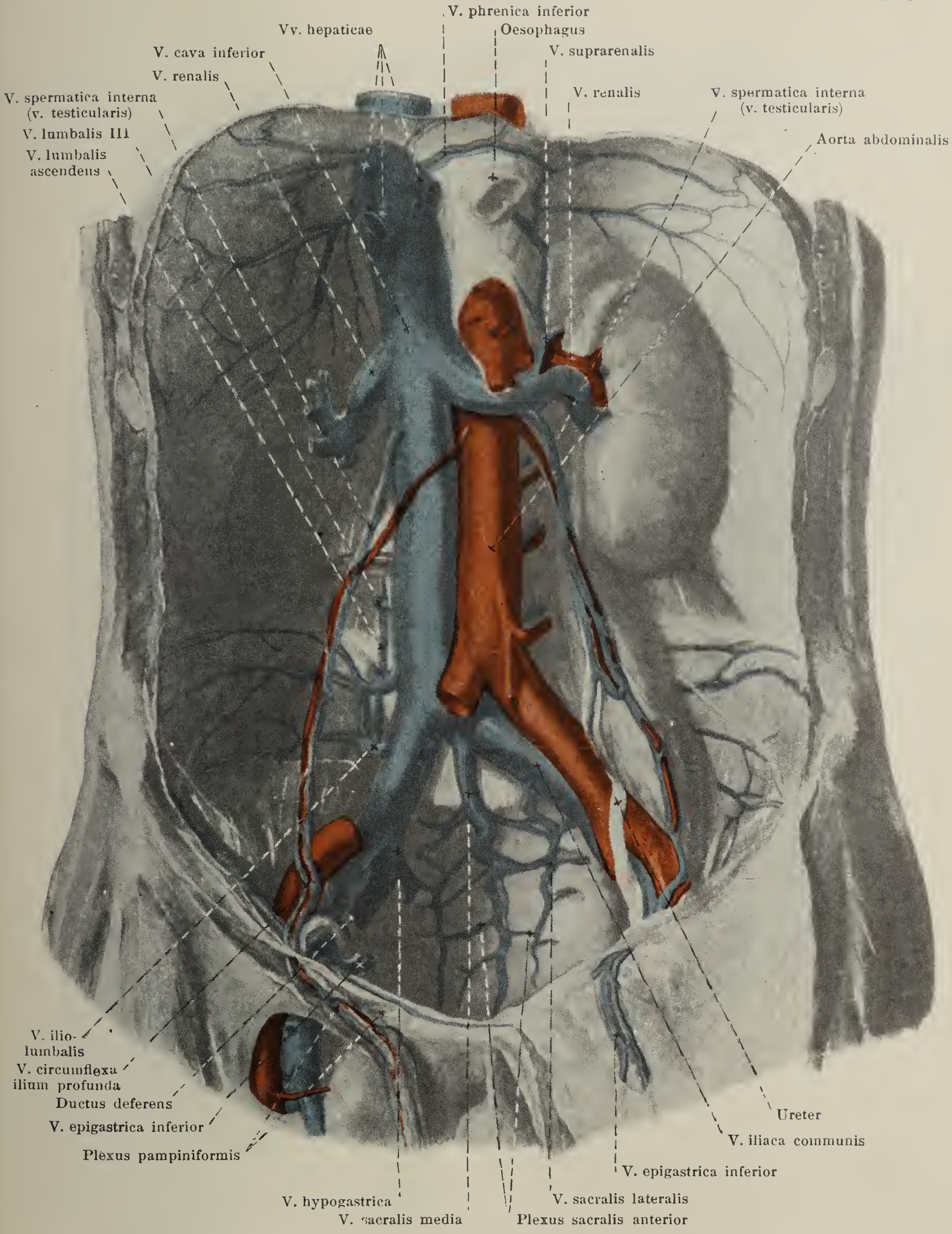
2. **V. renalis** (renal veins) (see also Fig. 686), paired, arises by the fusion of from three to five branches near the hilus renalis, runs medianward and at the same time somewhat upward at the level of the 1st lumbar vertebra or a little deeper in front of the a. renalis and opens into the lateral wall of the v. cava. The left v. renalis is somewhat the larger and longer; it lies usually in front of the aorta just beneath the origin of the a. mesenterica superior. It receives tributaries from the capsula adiposa of the kidney and from the ureter; the left v. renalis receives also usually the v. spermatica sinistra. In addition the left vein anastomoses very frequently with the v. hemiazygos, the right sometimes with the v. azygos. The vv. renalis rarely possess valves at their mouths.

3. **V. suprarenalis** (suprarenal veins) (see also Fig. 692), paired, comes from the anterior surface of the adrenal and opens on the right side usually into the v. cava, on the left side into the v. renalis. It is devoid of valves.

4. **V. spermatica interna** (spermatic vein) (see also Figs. 551, 553 and 554), paired. accompanies the a. spermatica interna directly and is separated from it only at its termination. It consists of from 2 to 3 anastomosing vessels which surround the artery like a plexus, receives branches from the ureter, from the peritonaeum and from the capsula adiposa of the kidney and unites finally to form a single trunk. The right vein opens obliquely into the anterior wall of the v. cava and there possesses efficient valves, the left goes almost at a right angle into the inferior wall of the v. renalis sinistra. The beginning of the vein is different in the two sexes.

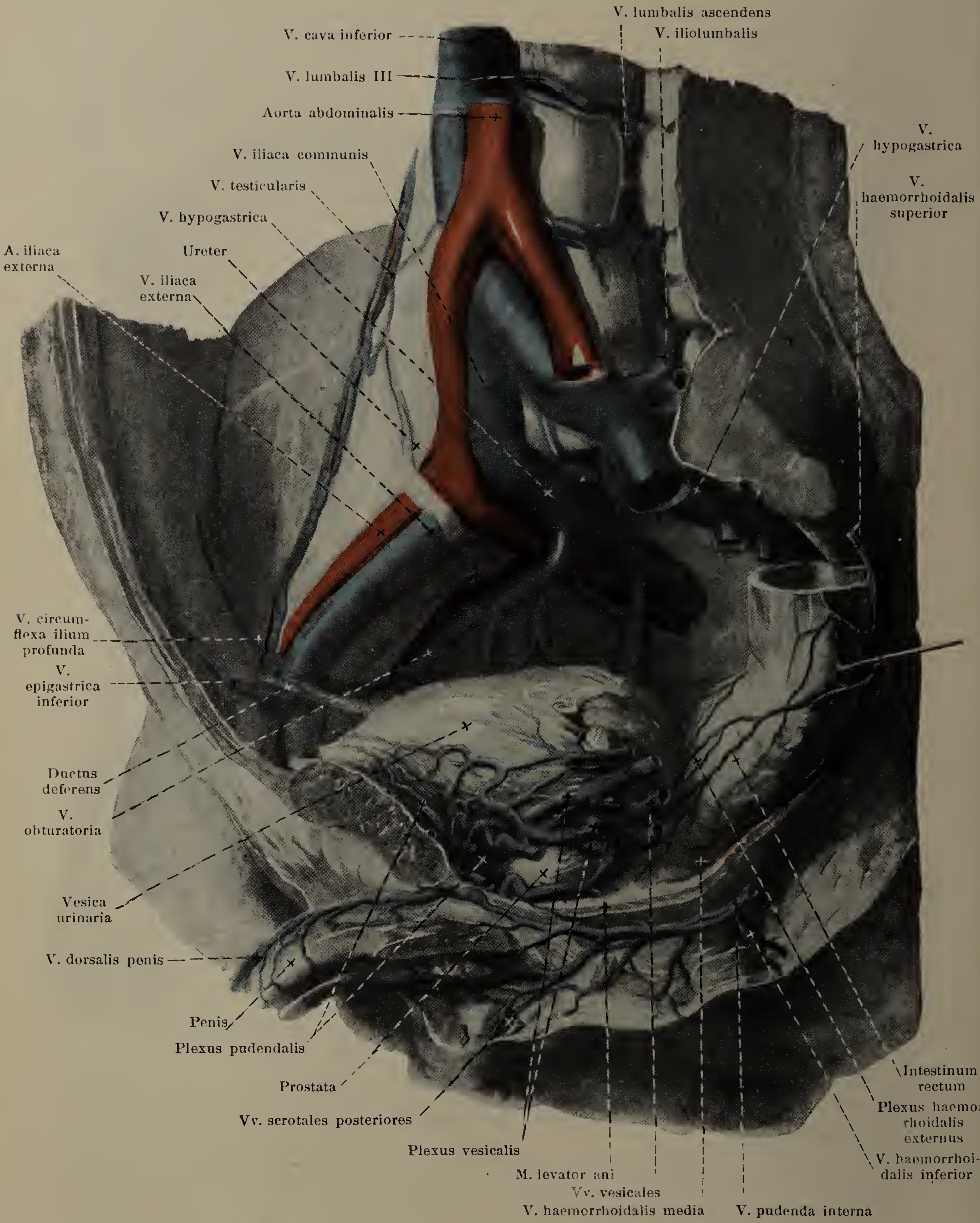
In the male, the *v. testicularis,* begins at the posterior margin of the testicle and epididymis with numerous fine and few thick branches (see also Fig. 703), which form a close plexus *(plexus pampiniformis)* around the artery inside the funiculus spermaticus, and extends with this through the canalis inguinalis. It anastomoses extensively on the testicle and epididymis with the v. spermatica externa. It possesses valves outside the canalis inguinalis, in the abdominal cavity only one near the annulus inguinalis abdominalis.

In the female, *v. ovarica,* it arises partly from numerous vessels, which leave the ovary at its hilus, partly from broad anastomoses with the upper part of the plexus uterovaginalis; in addition it receives some branches from the lig. teres uteri and from the tuba uterina. All these branches, anastomosing, form a close plexus *(plexus pampiniformis)* around the artery, inside the lig. suspensorium ovarii and are devoid of valves.



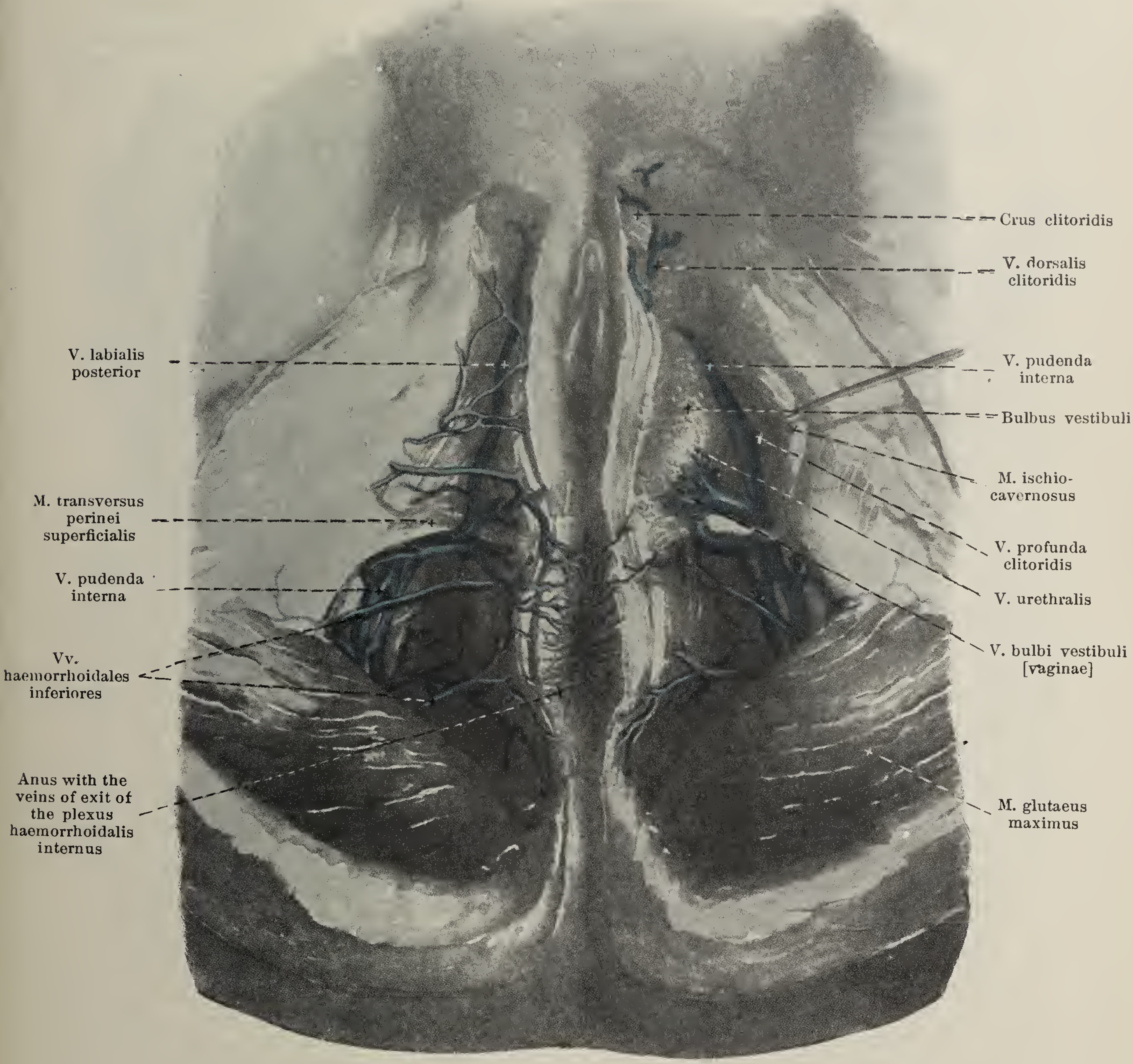
550. Vena cava inferior in the male, viewed from in front.

(On the right side the kidney has been removed, a piece of the m. psoas and of the a. iliaca communis has been cut out; on the left side the abdominal wall has been reflected downward.)



551. Veins of the male pelvis, right half, viewed from the left.

(The left m. psoas major has been removed, the rectum has been drawn somewhat to the side.)



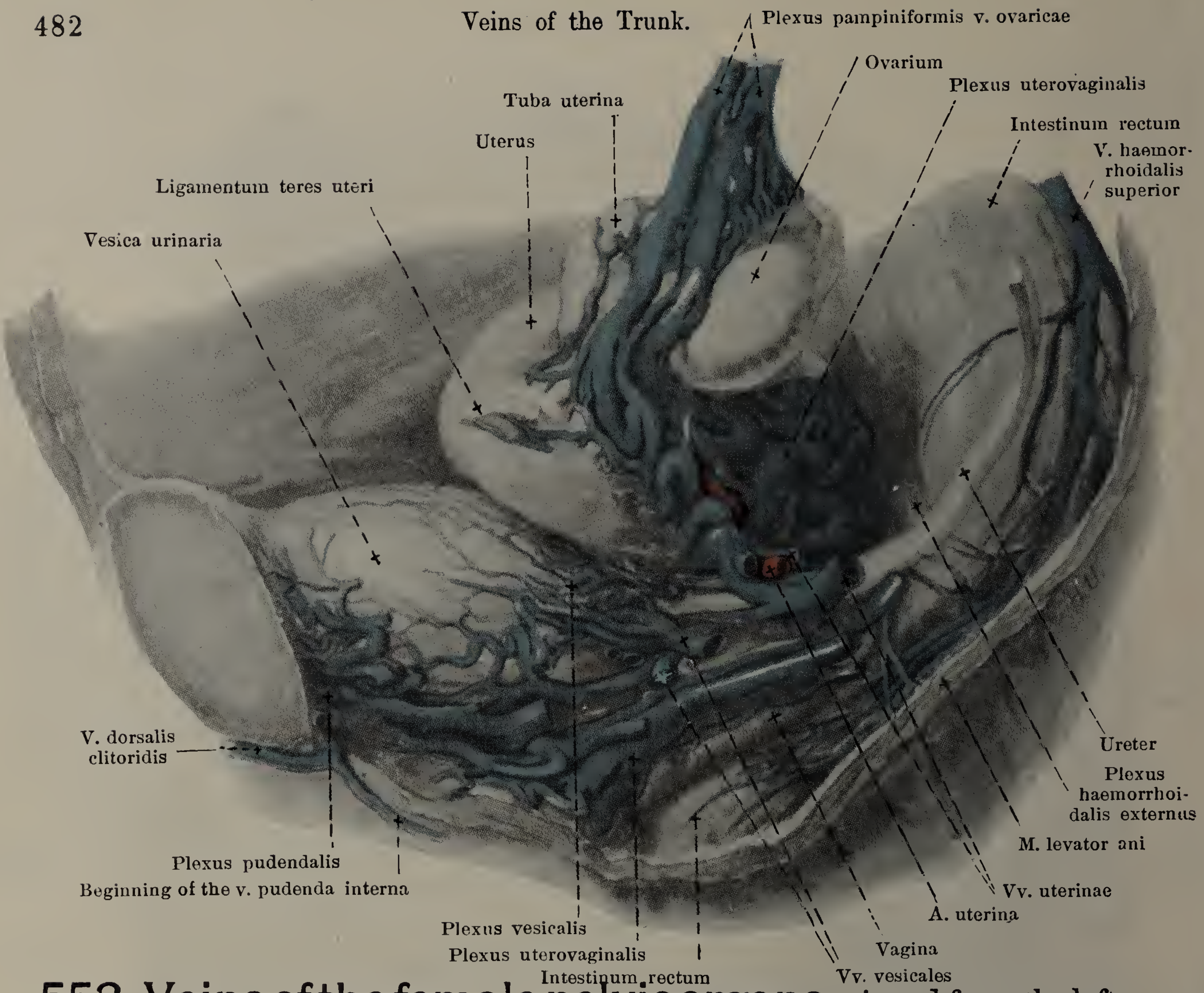
552. Veins of the female perineum (see Fig. 525).

V. iliaca communis *(common iliac vein)* (see Figs. 550 and 558), paired, devoid of valves, behind and to the right of artery, arises from the *v. hypogastrica* and the *v. iliaca externa.* It frequently anastomoses with the v. lumbalis ascendens. Branch of the left vein:

V. sacralis media (middle sacral vein), unpaired, often double below, near the a. sacralis media, forms with branches of the vv. sacrales laterales the *plexus sacralis anterior* (see p. 484); it is connected with the plexus haemorrhoidalis externus and vesicalis.

V. hypogastrica *(hypogastric vein)* (see Figs. 550 and 551) lies directly behind the a. hypogastrica. Its branches possess valves only outside the pelvis. Branches:

1. **V. pudenda interna** (O. T. internal pudic vein) (see also Figs. 551 and 554) begins below the symphysis ossium pubis with an anastomosis from the v. dorsalis penis (clitoridis) and receives the *vv. profundae penis (clitoridis), vv. urethrales, vv. bulbi urethrae (bulbi vestibuli [vaginae]), vv. scrotales (labiales) posteriores* and *vv. haemorrhoidales inferiores;* the latter are connected with the plexus haemorrhoidales. All the branches correspond to the arteries of the same name. The vein usually runs first beside the a. penis (clitoridis) in the trigonum urogenitale and then (for the most parst double) accompanies the a. pudenda interna.



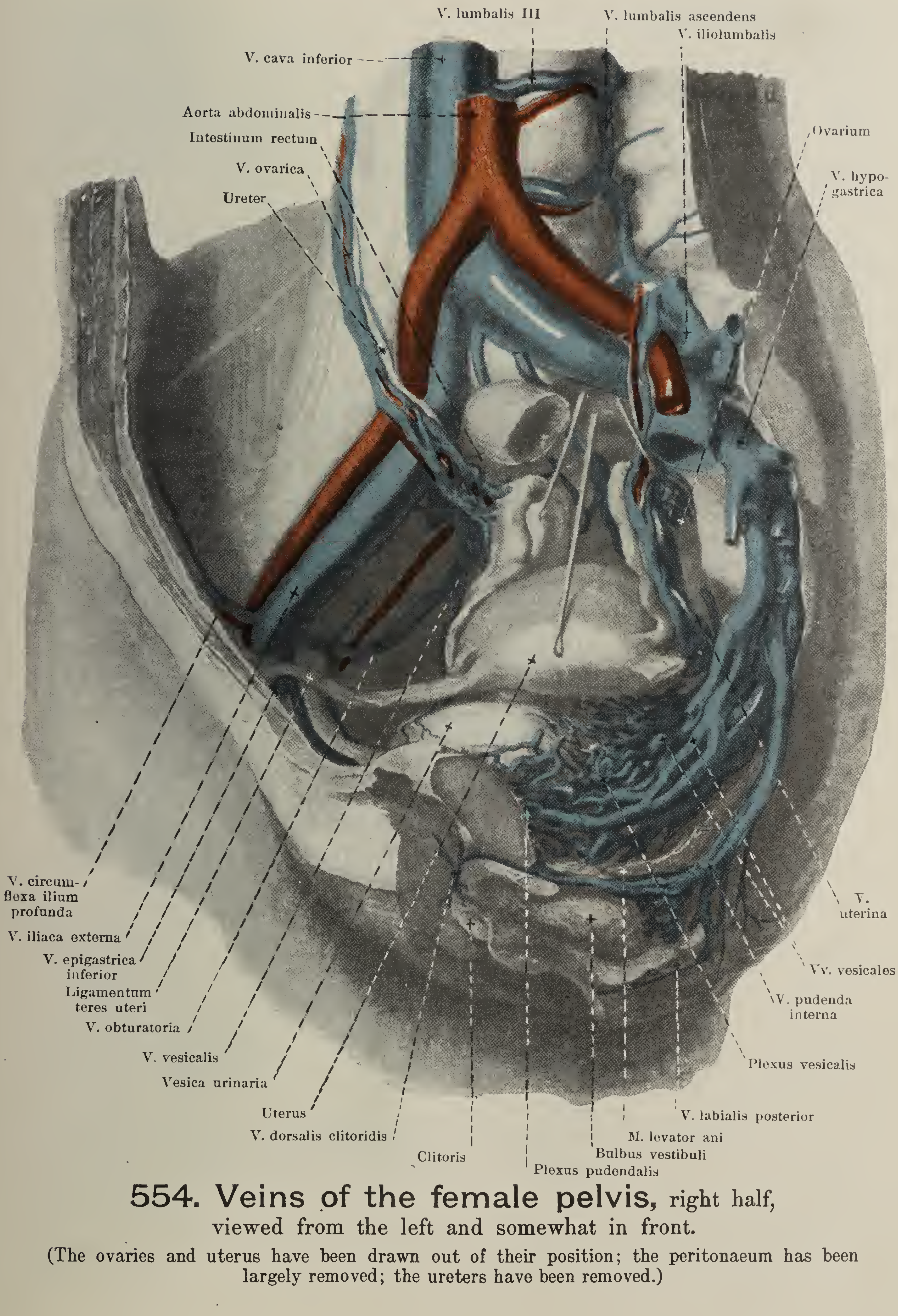
553. Veins of the female pelvic organs, viewed from the left.
(The superficial layers of the venous plexuses [see Fig. 554] have been removed; the peritonaeum has been for the most part removed.)

2. **Plexus haemorrhoidalis internus** (see Figs. 552 and 627) in the tela submucosa of the rectum, with ampulla-like dilatations in the region of the annulus haemorrhoidalis (see also p. 547) empties partly into a delicate, superficial network at the anus, partly by means of numerous perforating branches into the **plexus haemorrhoidalis externus** (see also Fig. 551) situated upon the external surface of the tunica muscularis. From the latter arise the *v. haemorrhoidalis superior*, devoid of valves (to the v. mesenterica inferior of the v. portae), the vv. *haemorrhoidales mediae*, with valves, paired (to the v. hypogastrica), which receive branches from the bladder, prostata and seminal vesicles in the male (uterus and vagina in the female) and the *vv. haemorrhoidales inferiores*, with valves, paired, from the neighborhood of the anus (to the v. pudenda interna); in addition branches go to the v. sacralis media.

3. **Plexus vesicalis** (see also Figs. 551, 554 and 730) surrounds the lower part of the bladder and in the male the basis prostatae lateralward and behind; it is, with valves in almost all its branches, connected with the following plexus, receives *vv. deferentiales* (from the testicle, along the ductus deferens) and is emptied on each side by means of several *vv. vesicales.*

4. **Plexus pudendalis** (see also Figs. 551 and 554) lies behind and over the lig. arcuatum pubis, in front of the prostata and bladder (in the male, the bladder and urethra in the female), receives the main trunk of the unpaired *v. dorsalis penis (clitoridis)* (see also Fig. 709), which runs between the lig. arcuatum pubis and the lig. transversum pelvis, is connected with the v. pudenda interna and with the plexus vesicalis and empties partly into the vv. vesicales, partly directly into the v. hypogastrica.

5. **Plexus uterovaginalis** (in the female) extends over the walls of the vagina and as an especially close plexus along the margo lateralis of the uterus, where it partly fills up the parametrium and surrounds the ureter. It is connected with the plexus pudendalis and haemorrhoidalis externus and empties on each side chiefly through the large *vv. uterinae*, which surround the a. uterina and form broad anastomoses with the plexus pampiniformis of the v. ovarica. There are almost no valves in the uterine veins, and those which are found can not be closed.



554. Veins of the female pelvis, right half, viewed from the left and somewhat in front.

(The ovaries and uterus have been drawn out of their position; the peritonaeum has been largely removed; the ureters have been removed.)

6. **V. iliolumbalis** (see Figs. 546, 550 and 551), in part double, accompanies the a. iliolumbalis and often opens into the v. iliaca communis. It receives the vv. intervertebrales (see p. 473), muscular veins and sometimes the v. lumbalis V, anastomoses with the vv. lumbalis ascendens, circumflexa ilium profunda and sacrales laterales and possesses many valves.

7. **Vv. sacrales laterales** (see Fig. 550), usually double, run near the a. sacralis lateralis and open into the v. hypogastrica or into a branch of the same. Their branches form, with those of the v. sacralis media, the *plexus sacralis anterior* upon the facies pelvina of the sacrum.

8. **V. obturatoria** (see Figs. 551 and 554) near the a. obturatoria; its branches are usually doubled; it forms a broad anastomosis in the pelvis with the v. iliaca externa, and sometimes opens into this. Its branches anastomose freely with the v. circumflexa femoris medialis.

9. **V. glutaea superior** (see Fig. 557) accompanies the a. glutaea superior; its branches are usually doubled. At its entrance into the pelvis its walls stand open and it possesses valves. Behind the m. piriformis it anastomoses with the v. glutaea inferior.

10. **V. glutaea inferior** (see Fig. 557), near the a. glutaea inferior; its branches, usually doubled, accompany the branches of the latter. It receives a large branch from the n. ischiadicus and anastomoses on the m. quadratus femoris by means of very wide vessels with the v. circumflexa femoris medialis and with the uppermost v. perforans of the vv. profundae femoris.

V. iliaca externa *(external iliac vein)* (see Figs. 550, 551 and 556) begins as the continuation of the *v. femoralis* behind the lig. inguinale, on the medial side of the a. iliaca externa and, as it ascends, becomes displaced behind the artery. It receives a broad anastomosis from the v. obturatoria and frequently possesses one (usually insufficient) valve. Branches:

1. **V. epigastrica inferior** (see Figs. 550, 551 and 556), usually doubled, accompanies the a. epigastrica inferior. It anastomoses with the vv. epigastricae superiores and behind the ramus superior ossis pubis with the v. obturatoria; in addition it receives the vv. parumbilicales, as well as the *v. spermatica externa* (see also p. 478) from the testicle and epididymis and branches from the vv. cutaneae abdominis. Below the navel it possesses numerous valves.

2. **V. circumflexa ilium profunda** (see Figs. 550, 551, 554 and 556), double in most of its course, surrounds the a. circumflexa ilium profunda like a plexus and often opens into the v. epigastrica inferior; in so doing it crosses the a. iliaca externa on its anterior or posterior surface. It anastomoses with the v. iliolumbalis and is supplied with valves.

V. femoralis *(femoral vein)* (see Fig. 556) is the continuation of the *v. poplitea* from the hiatus tendineus [adductorius] on. In the canalis adductorius [Hunteri] it lies behind the a. femoralis and somewhat lateralward from it; further up it runs for the most part exactly behind the artery, and arrives finally on the medial side of the artery in the fossa iliopectinea. In its lower portion two *vv. comitantes* also run close to the artery. It possesses usually 4—5 pairs of valves. Branches:

1. **V. epigastrica superficialis** (see also Fig. 559) is situated in the subcutaneous tissue and carries the blood downward from the lower half of the anterior abdominal wall. It opens in the fossa ovalis separately or, united with neighboring veins, into the v. femoralis or into the v. saphena magna and possesses valves which conduct downward.

2. **V. circumflexa ilium superficialis** (see Fig. 559), sometimes doubled for part of its course, close to the corresponding artery in the subcutaneous tissue, opening either independently or in common with the v. epigastrica superficialis. It is supplied with valves.

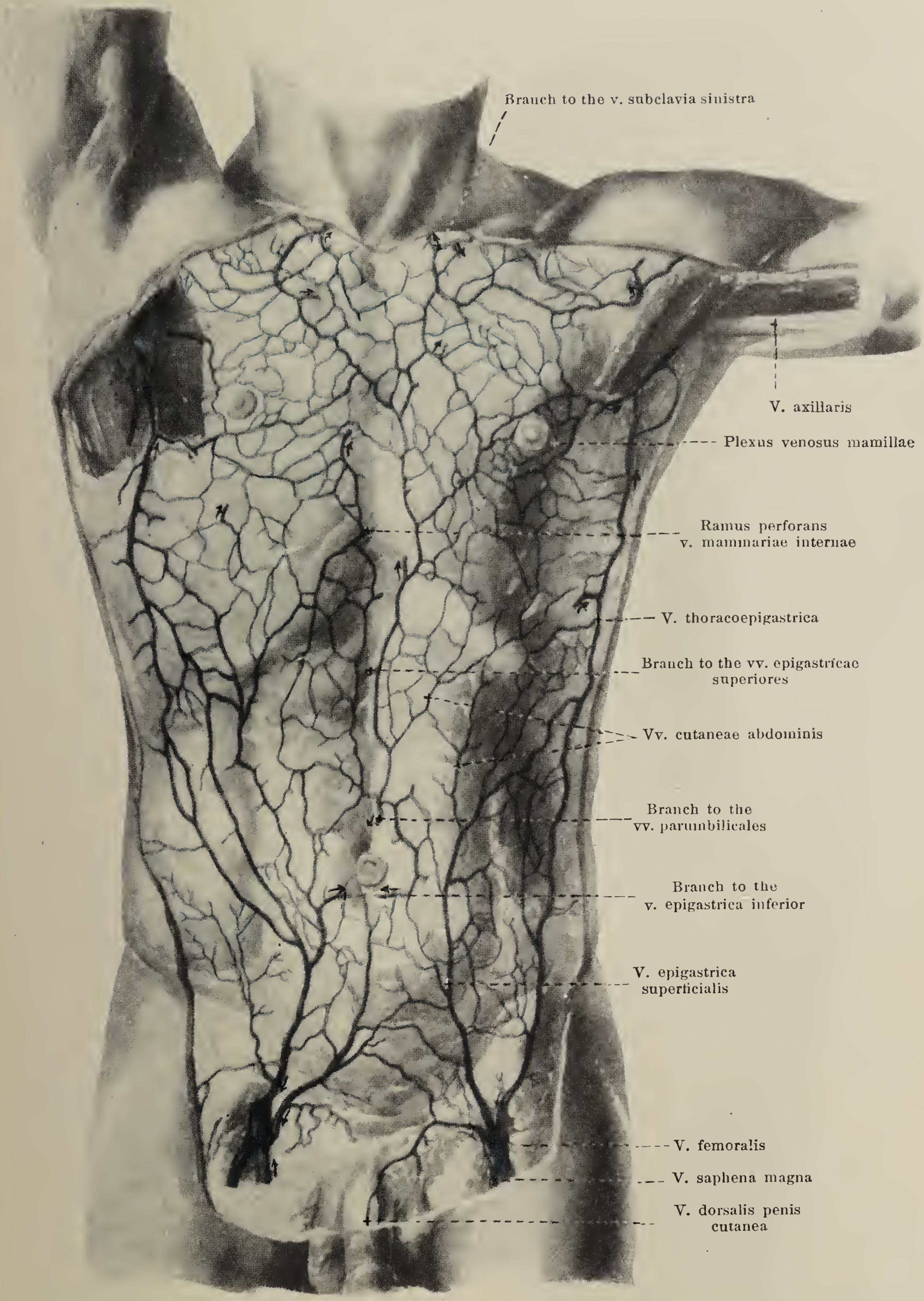
3. **V. thoracoepigastrica,** single or doubled for long distances, extends, on the anterior or lateral wall of the trunk, in the subcutaneous tissue, from the axilla as far as the fossa ovalis. Its middle portion is devoid of valves, in its upper part valves direct the blood uppard to the axilla, in its lower part downward to the fossa ovalis. Above, the vein opens into the v. thoracalis lateralis (see p. 471), below it goes either separately or united with the v. epigastrica superficialis into the v. femoralis.

4. **Vv. pudendae externae** (see also Fig. 559), near the aa. pudendae externae, frequently flow into the v. saphena magna; they receive branches from the skin of the abdomen, from the scrotum (or the labia majora), *vv. scrotales (labiales) anteriores,* and from the penis (or the clitoris), *v. dorsalis penis (clitoridis) cutanea;* the latter runs unpaired or doubled upon the fascia penis (clitoridis) as far as the symphysis pubis and there bends lateralward.

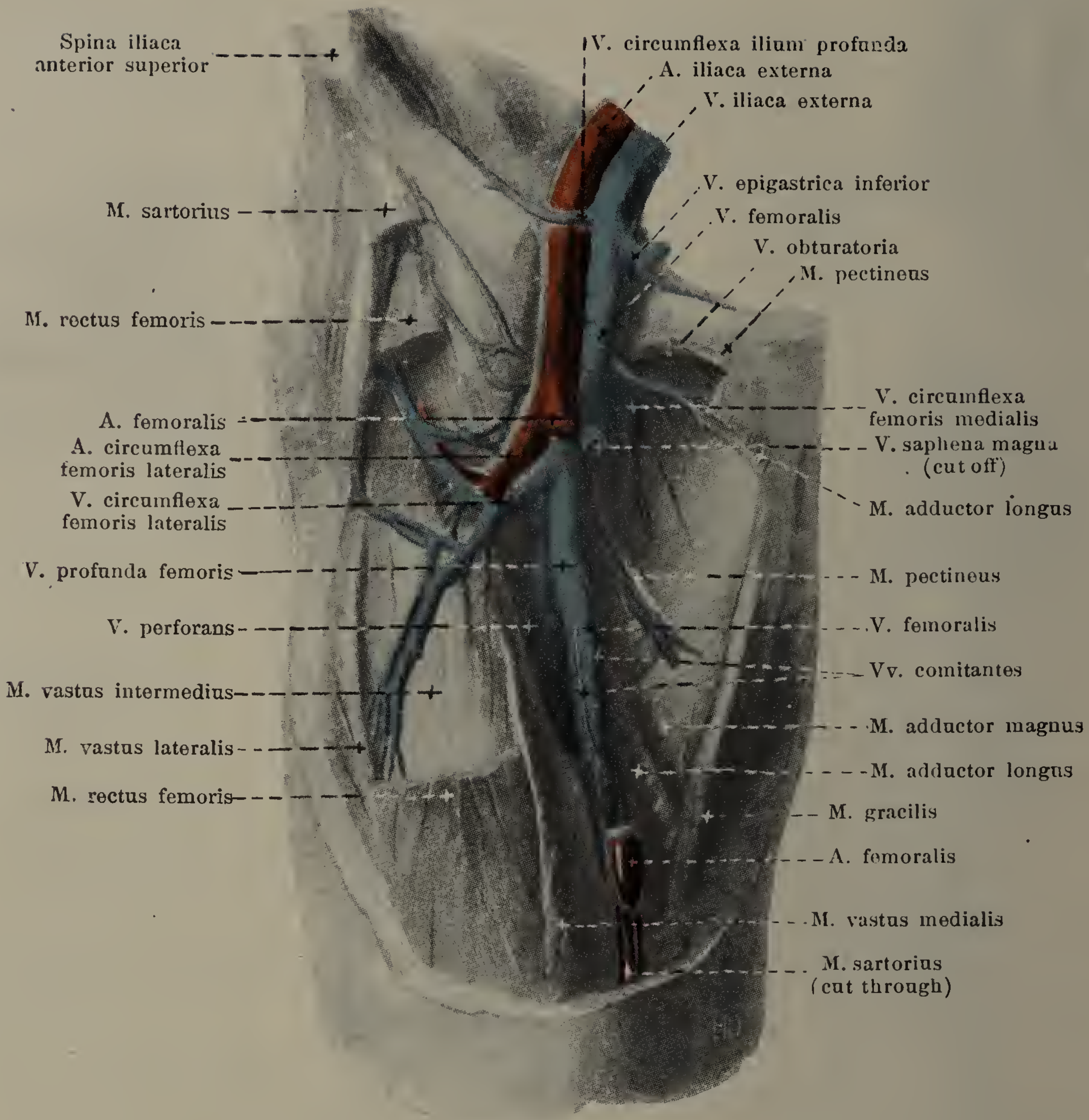
(Continuation see p. 486.)

Vv. cutaneae abdominis et pectoris form, in the subcutaneous tissue of the abdominal and thoracic wall, a network of vessels, supplied with valves, from which the blood is led away on each side 1st by superficial vessels to the neck, to the axilla (v. thoracoepigastrica) and to the fossa ovalis (vide supra), 2nd by deep, perforating vessels to the thoracic cavity (to the vv. mammaria interna and intercostales), to the peritoneal cavity (vv. parumbilicales) and to the veins of the anterior abdominal wall (vv. epigastricae superiores et inferior).

In the neighborhood of the papilla mammae the vv. cutaneae form a wreath of vessels of uneven caliber, the *plexus venosus mamillae.*


Branch to the v. subclavia sinistra
V. axillaris
Plexus venosus mamillae
Ramus perforans v. mammariae internae
V. thoracoepigastrica
Branch to the vv. epigastricae superiores
Vv. cutaneae abdominis
Branch to the vv. parumbilicales
Branch to the v. epigastrica inferior
V. epigastrica superficialis
V. femoralis
V. saphena magna
V. dorsalis penis cutanea

555. Superficial veins of the trunk,
viewed from in front (after W. Braune).
(The arrows indicate the way in which the current is directed by the valves.)



556. V. femoralis dextra, viewed from in front.

(The lig. inguinale and the mm. sartorius, rectus femoris, pectineus and adductor longus have been entirely or partially removed; a piece has been cut out of the a. femoralis.)

V. femoralis (continued):

5. **V. saphena magna** (see p. 489).

6. **V. profunda femoris** accompanies the a. profunda femoris and possesses several pairs of valves. Branches:

a) *Vv. perforantes* (see also Fig. 557), partly doubled, arise on the posterior surface of the m. adductor magnus and communicate freely there by longitudinal anastomoses with one another, with the vv. glutaea inferior, circumflexa femoris medialis and with the v. poplitea; they then perforate the mm. adductores near the aa. perforantes.

b) *Vv. circumflexae femoris mediales* (see also Fig. 557) run near the corresponding arteries and anastomose freely behind, on the m. quadratus femoris, with the vv. glutaea inferior and perforans I, in front with the v. obturatoria. They are supplied with valves.

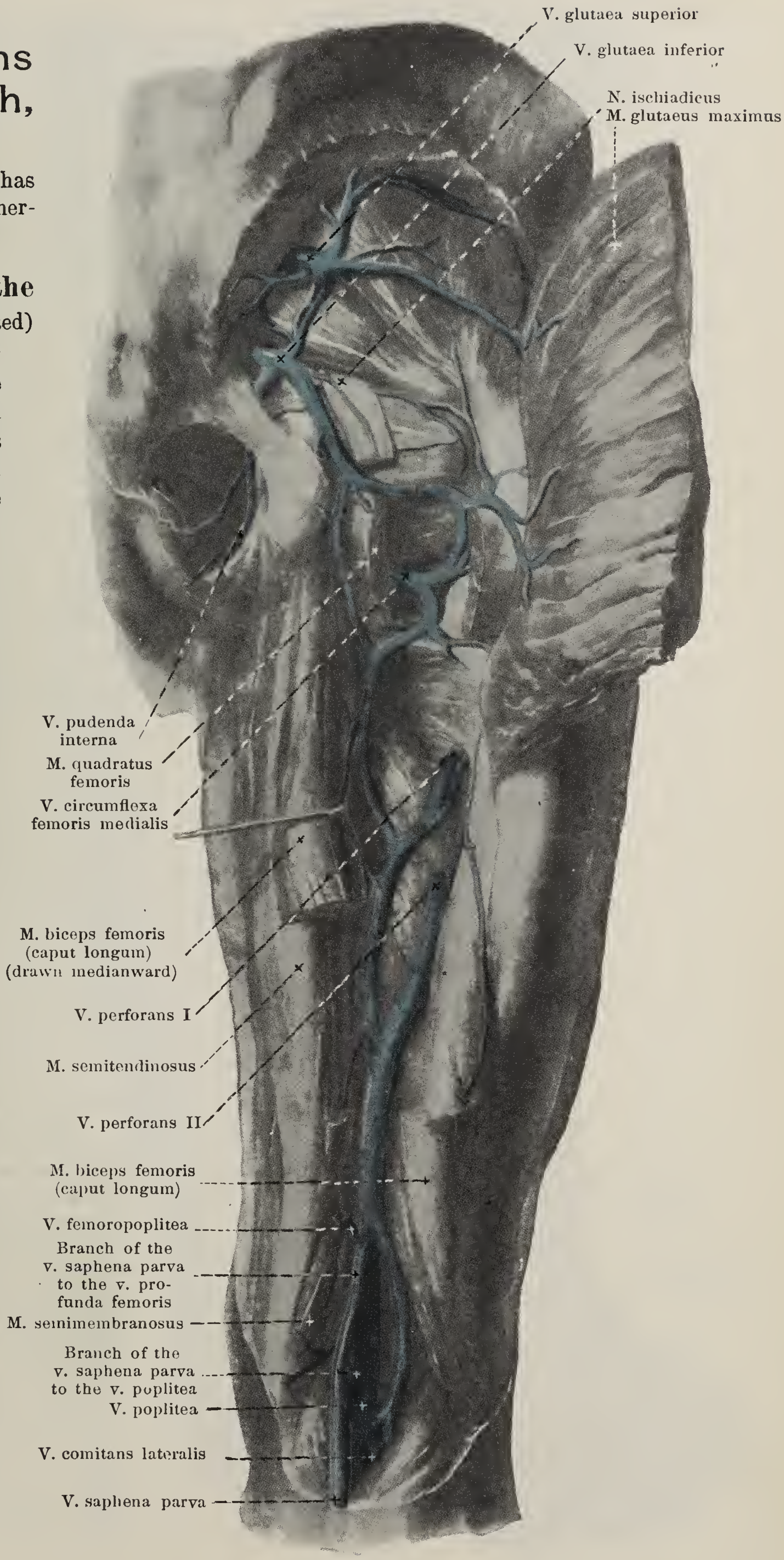
c) *Vv. circumflexae femoris laterales*, supplied with valves, accompany the a. circumflexa femoris lateralis and anastomose with the preceding and with the v. glutaea inferior.

V. poplitea *(popliteal vein)* (see Figs. 557 and 895) arises from the union of the *vv. tibiales* and runs just behind the a. poplitea, in its distal part at the same time somewhat medianward, in its proximal part somewhat lateralward from it. Besides, near the artery there is below a *v. comitans lateralis*, above a *v. comitans medialis*. It is supplied with valves, receives the v. saphena parva (see p. 490) and the *vv. articulares genus* (double near the corresponding arteries, not illustrated) and anastomoses with the lower vv. perforantes.

557. Deep veins of the right thigh,

viewed from behind.

(The m. glutaeus maximus has been reflected lateralward; otherwise like Fig. 528.)



The **deep veins of the foot and leg** (not illustrated) accompany the arteries, usually two to each artery, and are plentifully supplied with valves. Numerous anastomoses with the superficial veins lead the blood in the back of the foot from the depth to the surface, in the sole of the foot, in the leg and in the thigh from the surface to the depth.

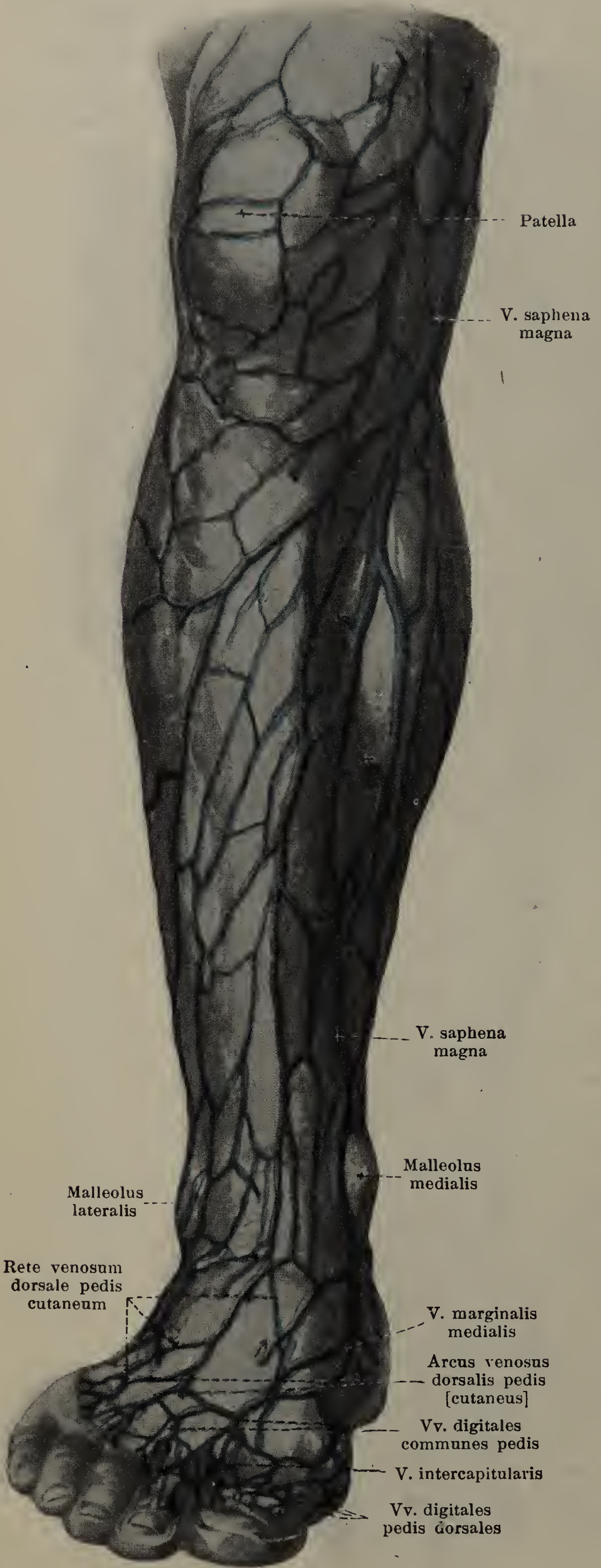
In the sole of the foot they begin as the *vv. digitales plantares* and then form the *vv. metatarseae plantares,* which empty partly through several *rami perforantes* into the deep and the superficial veins of the back of the foot, partly into the *arcus venosus plantaris profundus.* From the latter go off the *vv. plantares laterales,* which by union with the finer *vv. plantares mediales* form the **vv. tibiales posteriores;** in the leg the latter receive the *vv. peronaeae.* The vv. plantares laterales also send an anastomosis to the v. saphena parva, the vv. plantares mediales to the v. saphena magna.

On the back of the foot the deep veins are relatively delicate; they begin as the *vv. metatarseae dorsales pedis* and are continued into the **vv. tibiales anteriores.**

558. Superficial veins of the right leg,

viewed from in front (after W. Braune.)

(The arrows indicate the way the stream is directed by the valves.)


Patella
V. saphena magna
V. saphena magna
Malleolus medialis
Malleolus lateralis
Rete venosum dorsale pedis cutaneum
V. marginalis medialis
Arcus venosus dorsalis pedis [cutaneus]
Vv. digitales communes pedis
V. intercapitularis
Vv. digitales pedis dorsales

The **superficial veins of the leg** form a continuous network in the subcutaneous tissue, varying in complexity, rich in valves, and permitting the recognition in it of single larger vessels which act as the principal canals of exit. They are connected with the deep veins by numerous anastomoses (for direction of current see p. 487).

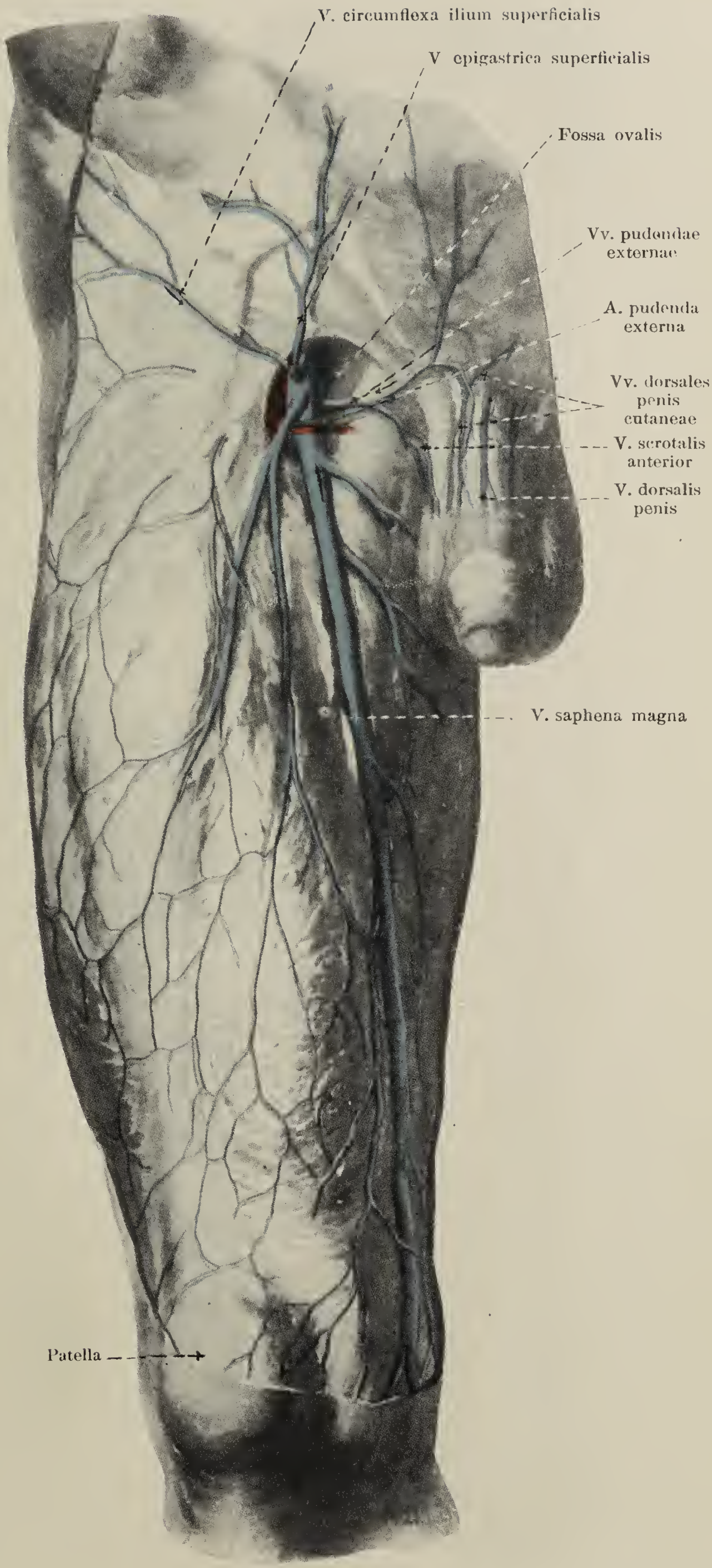
In the **sole of the foot** (not illustrated) there is a very close network *(rete venosum plantare cutaneum)*, which possesses different channels of outflow. In the first place branches go to the deep veins, secondly, however, and chiefly, the blood is led away through superficial trunks around the borders of the foot to the dorsum of the foot. These pass at the medial and lateral margins of the foot into the vv. marginales medialis and lateralis of the dorsum of the foot, dorsalward over the margin of the heel toward the leg, and forward into a larger vessel *(arcus venosus plantaris cutaneus)*, which runs in the toe-ball furrow at the distal margin of the fasciculi transversi aponeurosis plantaris and is continued over the medial and lateral margins of the foot into the beginnings of the vv. marginales (vide infra). This vascular arch receives superficial branches from the toes and sends off into the space between each two toes single or double *vv. intercapitulares* to the vv. digitales dorsales pedis.

On the **back of the foot** the veins begin at the toes as the *vv. digitales pedis dorsales*, which unite after receiving the vv. intercapitulares to form the short *vv. digitales communes pedis* and flow into the *arcus venosus dorsalis pedis [cutaneus]*; this is an irregular chain of anastomoses between the vv. digitales communes and the vv. marginales and lies upon the distal portion of the ossa metatarsalia. Proximalward from it lies the irregularly shaped *rete venosum dorsale pedis cutaneum*, which receives many tributaries from the depth and is continued into the anterior network of the leg. In the network, near the lateral and medial margins of the foot, can be made out on each side a larger vessel, the *v. marginalis lateralis* (see Fig. 560) and the *v. marginalis medialis*, which chiefly receive tributaries from the rete venosum plantare cutaneum.

559. Superficial veins of the right thigh,

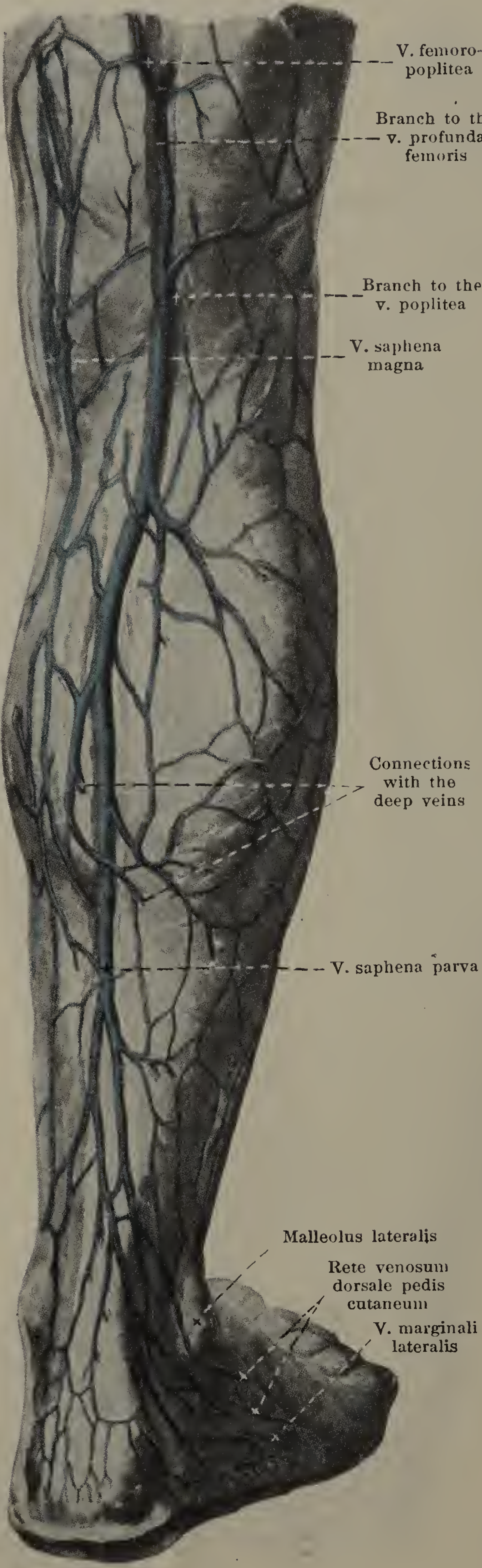
viewed from in front.

(The arrows indicate the way the current is directed by the valves.)



In the plexus of the superficial veins of the leg two large venous trunks stand out above the foot, the *v. saphena magna* and the *v. saphena parva*, of which the latter belongs essentially to the leg alone.

V. saphena magna (see also Figs. 556 and 558) begins in front of the medial malleolus as the continuation of the v. marginalis medialis and there receives superficial branches from the rete venosum plantare cutaneum and deep branches from the vv. plantares mediales. It then runs almost vertically upward upon the facies medialis tibiae, makes a slight curve behind the condyli mediales of the tibia and femur and then goes fairly straight but obliquely upward on the medial and anterior surface of the thigh, and enters the anterior medial wall of the v. femoralis in the fossa ovalis. In its entire course it is situated subcutaneously upon the fascia cruris and fascia lata. On its way it receives numerous branches from the superficial networks of the heel, of the leg and of the thigh, as well as veins from the tibia, and anastomoses manifoldly with the v. saphena parva. The superficial veins coming from the back of the thigh often form a separate trunk, the *v. saphena accessoria* (not illustrated), which accompanies the v. saphena magna medianward at a variable distance from it and empties into it at an inconstant level.


V. femoropoplitea
Branch to the v. profunda femoris
Branch to the v. poplitea
V. saphena magna
Connections with the deep veins
V. saphena parva
Malleolus lateralis
Rete venosum dorsale pedis cutaneum
V. marginali lateralis

560.
Superficial veins of the right leg,

viewed from behind (after W. Braune).

(The arrows indicate the way the current is directed by the valves.)

V. saphena parva (see also Fig. 557) begins behind the lateral malleolus as the continuation of the v. marginalis lateralis of the foot; in its formation there takes part, besides superficial branches of the rete venosum plantare cutaneum, also an anastomosis from the deep vv. plantares laterales. It runs at first on the lateral margin, then on the posterior surface of the tendo calcaneus [Achillis]; farther up ensheathed in a duplicature of the superficial layer of the fascia cruris, it lies in the groove between the two heads of the m. gastrocnemius (see also Fig. 880). The mouth of the v. saphena parva arises sometimes in the leg in the v. saphena magna or in deep veins; most frequently it embrouches undivided into the hollow of the knee in the v. poplitea, sometimes also divided into the latter as well as into the v. saphena magna or into deeper thigh veins; sometimes the mouth arises above the hollow of the knee into deep, posterior veins or the v. saphena magna. The *v. femoropoplitea* runs as a small vessel superficially along the thigh and empties its contents downward into the v. poplitea and into deep thigh veins or only into the latter, upward under the m. glutaeus maximus into the vv. glutaeae. The v. saphena parva receives in its course numerous branches from the superficial network of the heel and of the leg and anastomoses usually manifoldly with the v. saphena magna.

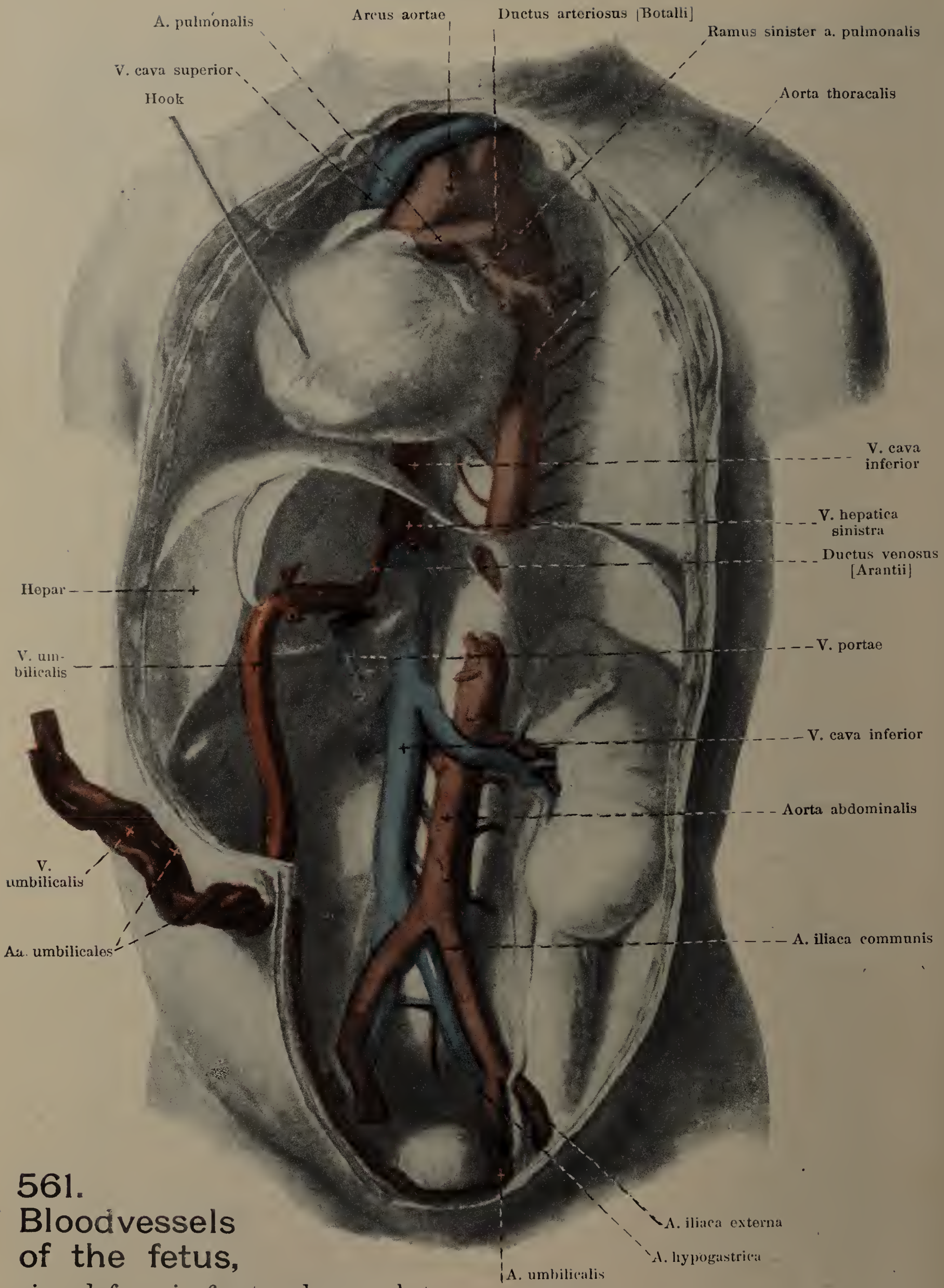
The fetal circulation.

During embryonic life the apparatus concerned in the circulation of the blood undergoes various transformations.

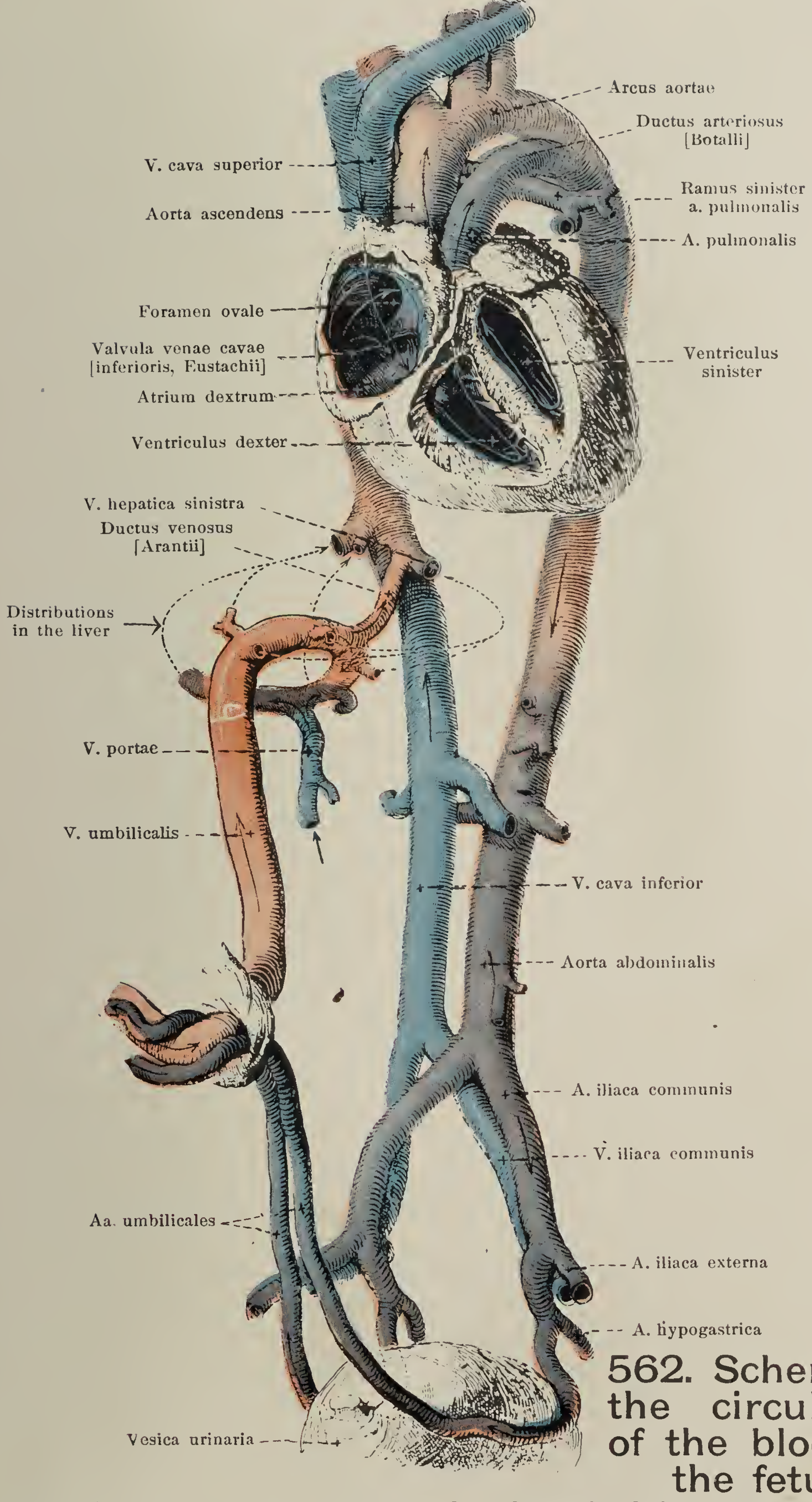
The arrangement which exists in the second half of pregnancy up to birth is designated the **placental circulation.** This presents the following peculiarities (see Figs. 561 and 562).

The **v. umbilicalis** *(umbilical vein)*, devoid of valves, leads the blood, which has become *arterial* in the placenta, through the *umbilical cord (funiculus umbilicalis)* to the navel and thence in the free margin of the lig. falciforme hepatis to the fossa venae umbilicalis of the liver. There a part of the blood goes through direct branches to the capillary system of the liver; another part becomes mixed, in that the v. umbilicalis connects with the left branch of the v. portae, with the venous contents of the portal vein (from the stomach, intestines, pancreas and spleen) and also arrives, along with this, in the capillary system of the liver; finally the third, smaller part runs directly to the left v. hepatica and thus to the v. cava inferior through the *ductus venosus [Arantii]*, which is situated in the fossa ductus venosi of the liver (see also Fig. 632) and connects the v. umbilicalis with the left v. hepatica. The v. cava inferior carries mixed blood therefore on its passage through the foramen venae cavae of the diaphragm. This is composed of 1st the pure arterial contents of the ductus venosus [Arantii], 2nd the contents of the vv. hepaticae, which carry the blood away from the capillary system of the liver, and 3rd the venous contents of the v. cava inferior (especially from the renal and suprarenal veins, pelvic veins and those of the lower extremities). Passing through the v. cava inferior, this blood reaches the right atrium, which, in the fetus, is freely connected with the left atrium through the foramen ovale (see Fig. 474). Since the foramen ovale is situated in the direction of the current of blood arriving through the v. cava inferior, and since, in addition, the valvula venae cavae [inferioris, Eustachii] to a certain extent hinders an alteration of this direction of the current, the main mass of blood streams through the foramen ovale into the left atrium and in so doing receives and mixes with only a part of the venous blood which arrives in the heart through the v. cava superior. Into the left atrium open the vv. pulmonales, and their blood, which in the fetus is venous, mixes with the other contents. The so-called *mixed arterial* blood thus arising goes especially to the upper half of the body through the left ventricle, the aorta ascendens and the arcus aortae and its large branches, the aa. anonyma, carotis sinistra and subclavia sinistra; only a part flows into the aorta thoracalis.

The v. cava superior carries the venous blood from the upper half of the body and (through the v. azygos which is markedly developed in the fetus) from the wall of the trunk, to the right atrium. Thence a small part passes through the foramen ovale into the left atrium, the larger part, however, mixed with a part of the blood from the v. cava inferior and hence called *mixed venous* blood, enters the right ventricle and passes into the a. pulmonalis. The a. pulmonalis divides, in the fetus, into three branches: the rami dexter et sinister, which go to the lungs (as yet not functioning) and the *ductus arteriosus [Botalli]*, which runs in the direction of the main trunk and enters, at the end of the arcus aortae, into the concave anterior wall of the latter. The greater part of the mixed venous blood now runs through this ductus arteriosus as far as the beginning of the aorta thoracalis; there it mixes with the residue of the mixed arterial blood coming from the end of the arcus aortae and passes through the branches of the aorta thoracalis and aorta abdominalis to the intestinal canal, to the genito-urinary organs, to the inferior portion of the wall of the trunk and to the lower extremities, chiefly, however, through the two **aa. umbilicales** (see p. 446) into the umbilical cord and to the placenta, where the blood again becomes arterialized.



561.
Bloodvessels of the fetus,
viewed from in front and somewhat from the left. (The abdominal and thoracic cavities have been widely opened, the lungs, the whole alimentary canal, the pancreas, the spleen, the left lobe of the liver and the serous membranes have been removed and the heart has been drawn aside to the right.)



562. Scheme of the circulation of the blood in the fetus, viewed from in front and somewhat from the left (see Fig. 561).
(The heart is in its correct position and has been partly opened. The arrows indicate the direction of the blood current.)

HAND-ATLAS
OF
HUMAN ANATOMY

BY

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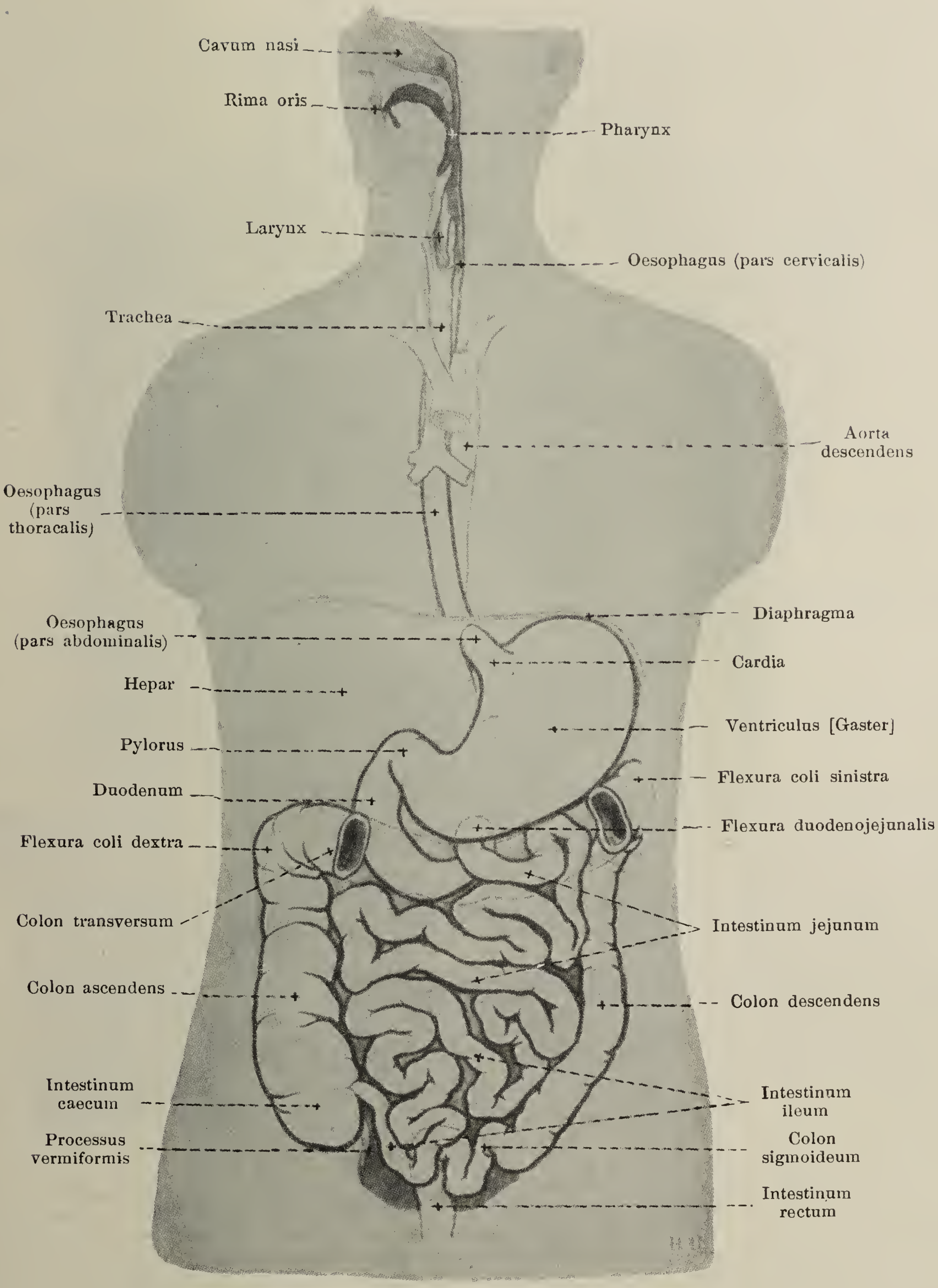
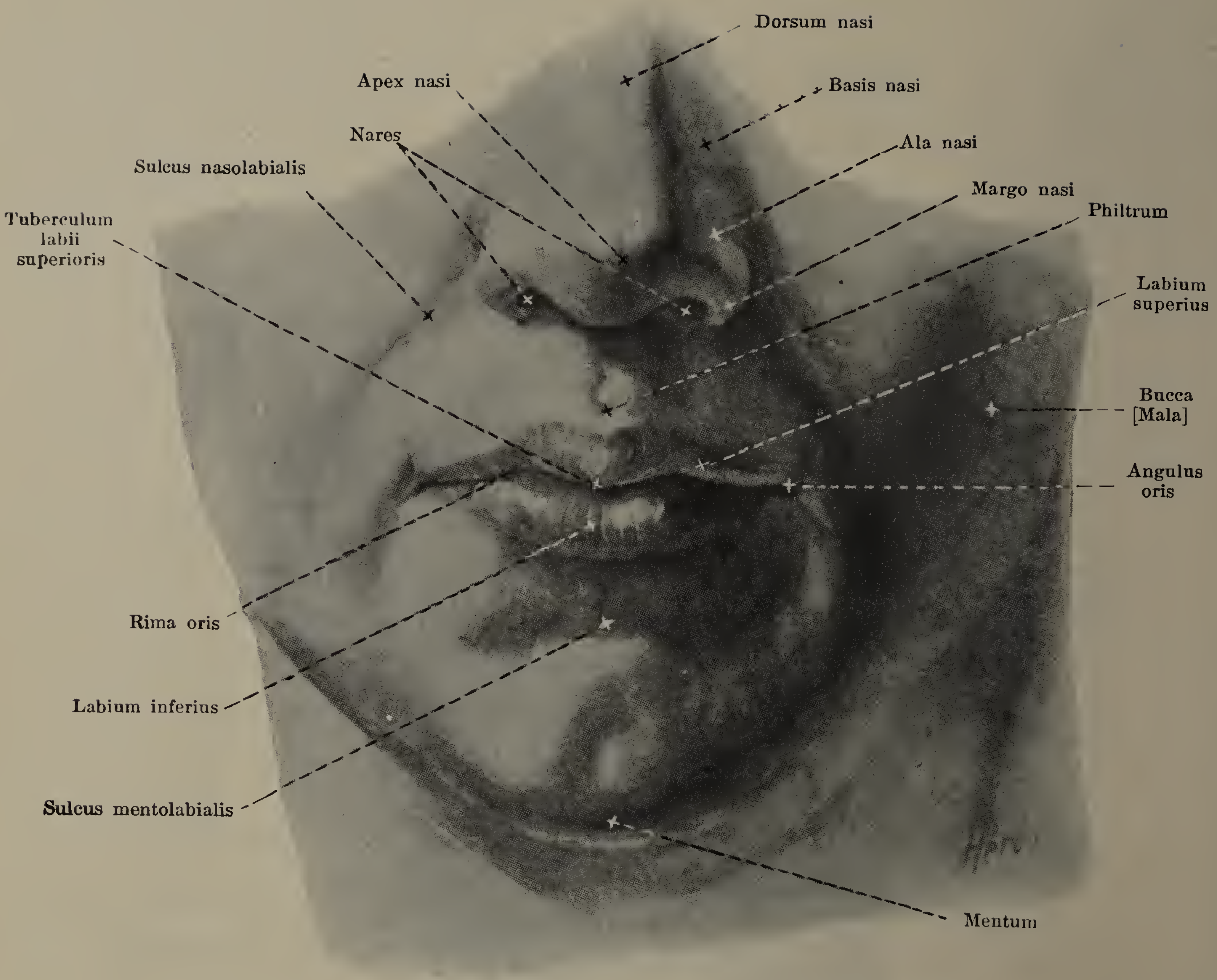


563. General view of the digestive tube,
somewhat schematic.

(A piece has been cut out of the transverse colon, its course being indicated by dotted lines. The inferior margin of the liver is indicated by a fine dotted line.)

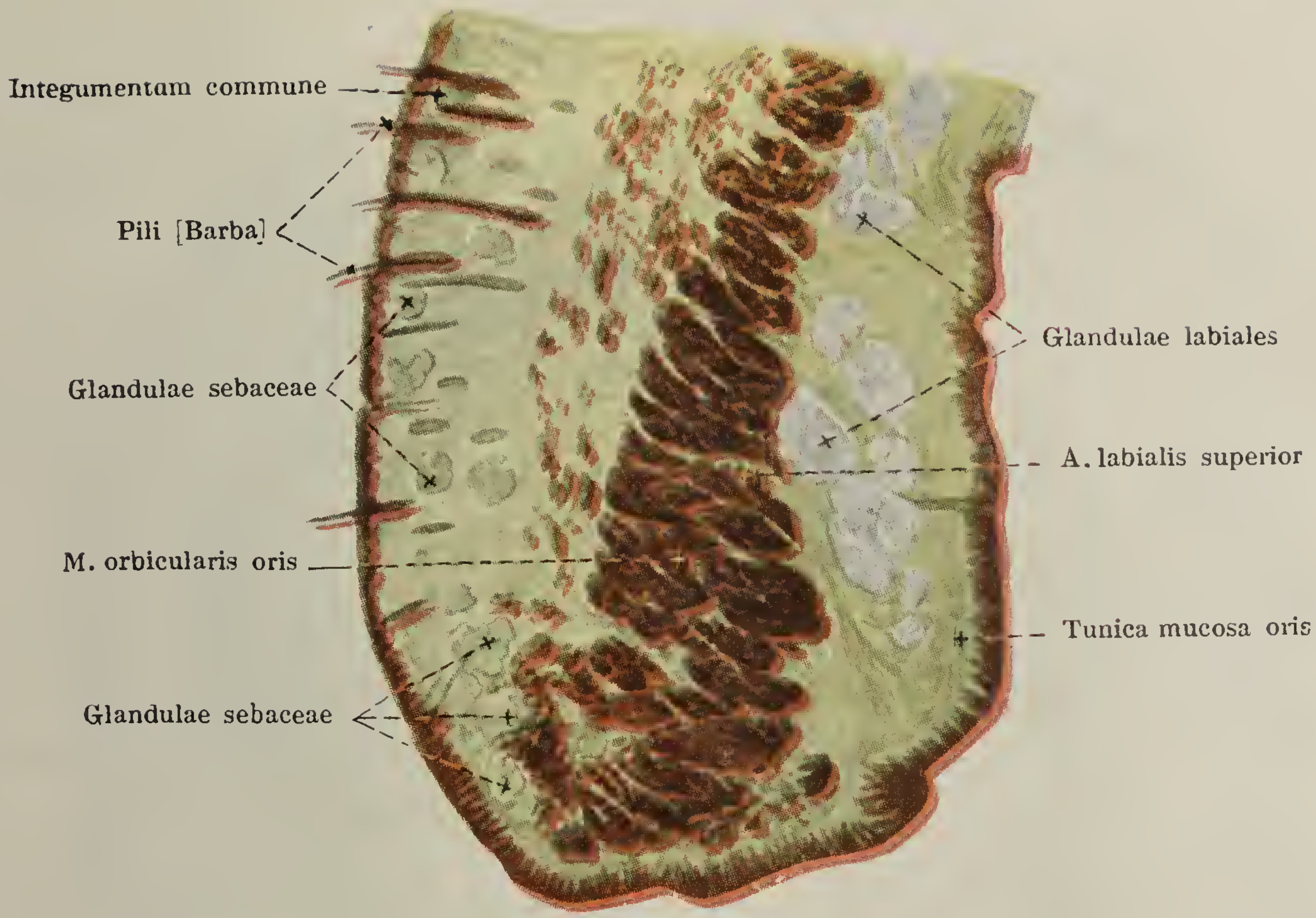


564. The mouth-slit and its surroundings.

The **cavum oris** *(mouth cavity)* (see Figs. 567, 568 and 594) is the beginning of the *apparatus digestorius* (digestive tube) but serves also as a path for the respiratory air and for the formation of sounds of speech. It opens in front through the mouth-slit; in front it is bounded by the mucous membrane of the lips, lateralward by that of the cheeks, above by the palate, below by the tongue and by the mucous membrane which extends from the under surface of the tongue to the gums; behind it is connected by the isthmus faucium with the pharynx. The processus alveolares of the upper jaw-bones and the pars alveolaris of the lower jaw-bone with the teeth fixed in them separate an anterior and lateral, narrow portion *(vestibulum oris)* from the mouth cavity proper *(cavum oris proprium).*

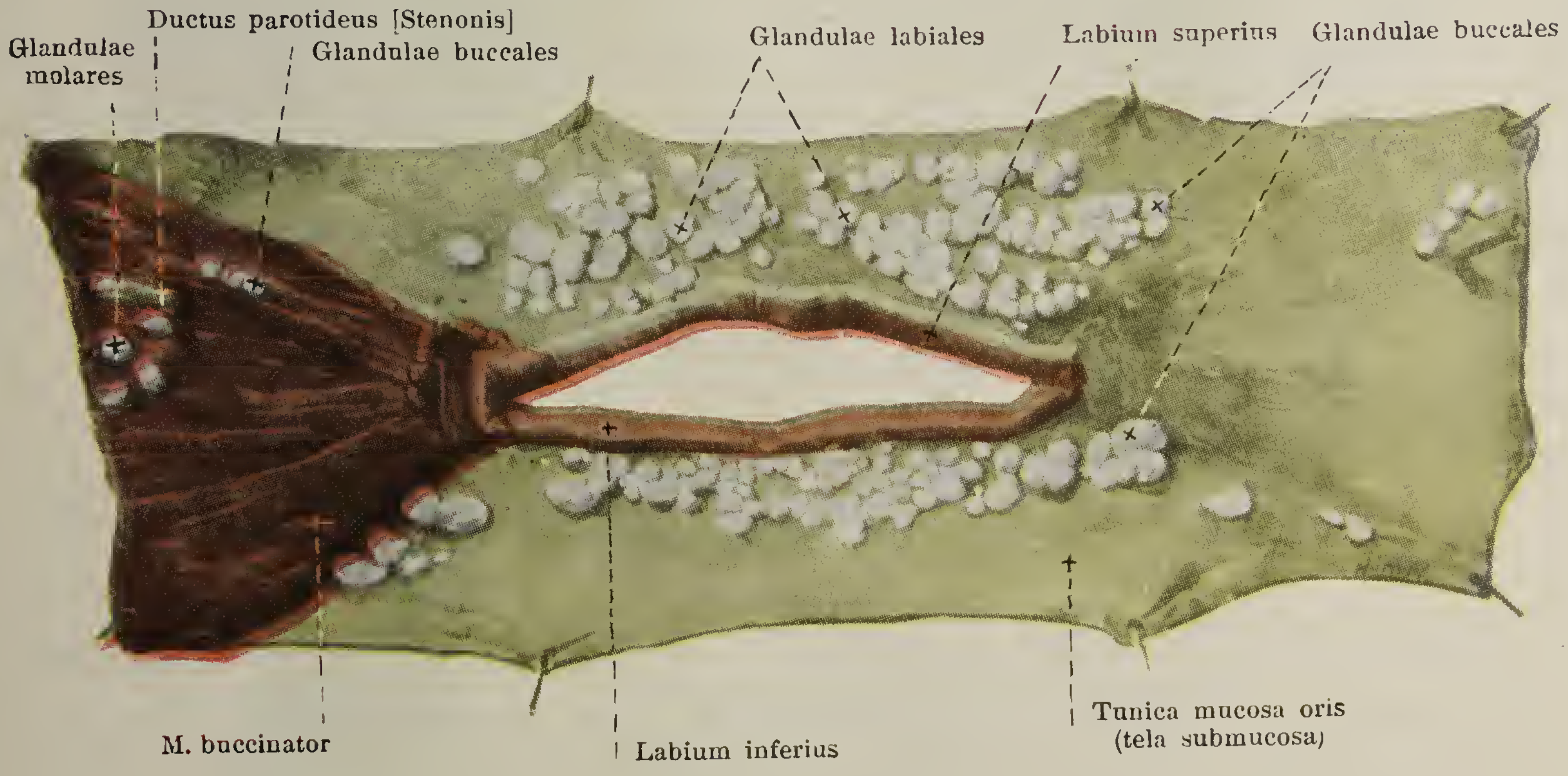
The **vestibulum oris** (see Figs. 567 and 568) when the mouth is closed and lips and teeth in contact, is a vertically placed, horse-shoe-shaped slit, which is connected with the mouth cavity proper only by means of the minute spaces between the teeth and on each side by a somewhat larger space between the hindermost molar teeth and the anterior margin of the ramus of the lower jaw.

The **lips** *(labia oris)* (see also Figs. 565—567, 589 and 594) are folds which are covered on the outer surface by skin, on the inner by the tunica mucosa oris and which contain, between these, the m. orbicularis oris (see p. 263). As *upper* and *lower lip (labium superius, labium inferius)* they bound the *rima oris (mouth-slit)* and go over into one another on each side, lateralward from its extremity *(angulus oris, angle of the mouth)*, by means of the *commissura labiorum.* In the median plane from the posterior surface of each lip a small perpendicular fold of mucous membrane *(frenulum labii superioris, frenulum labii inferioris)* extends to the anterior surface of the jaw-bones. Between the muscular layer and the mucous membrane, in the tela submucosa, lie numerous *labial glands (glandulae labiales)*, some as large as a grain of millet; their ducts open upon the surface of the mucous membrane.



565. Cross-section through the upper lip.

Magnification 4 : 1.

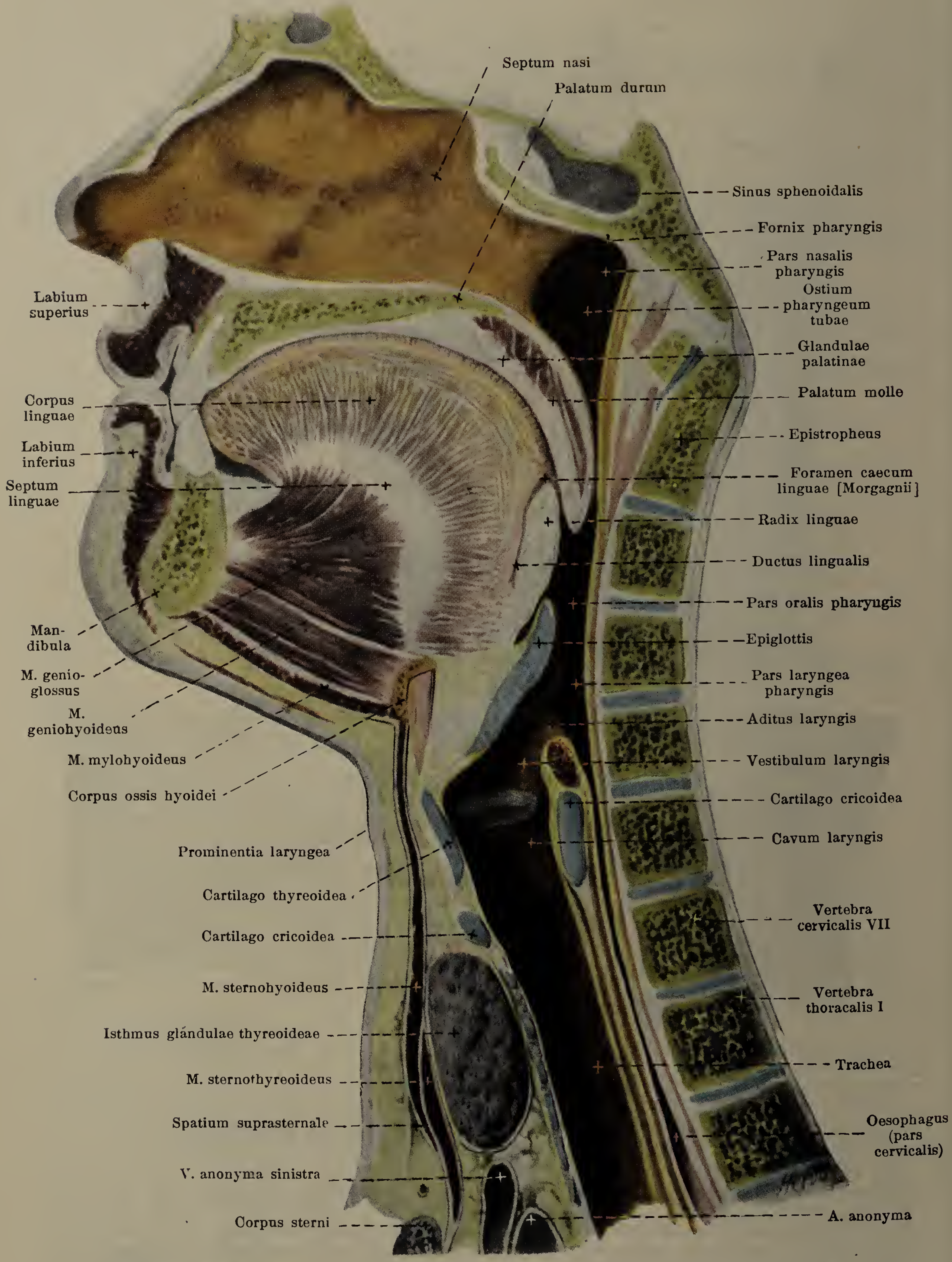


566. Glands of the lips and cheeks,

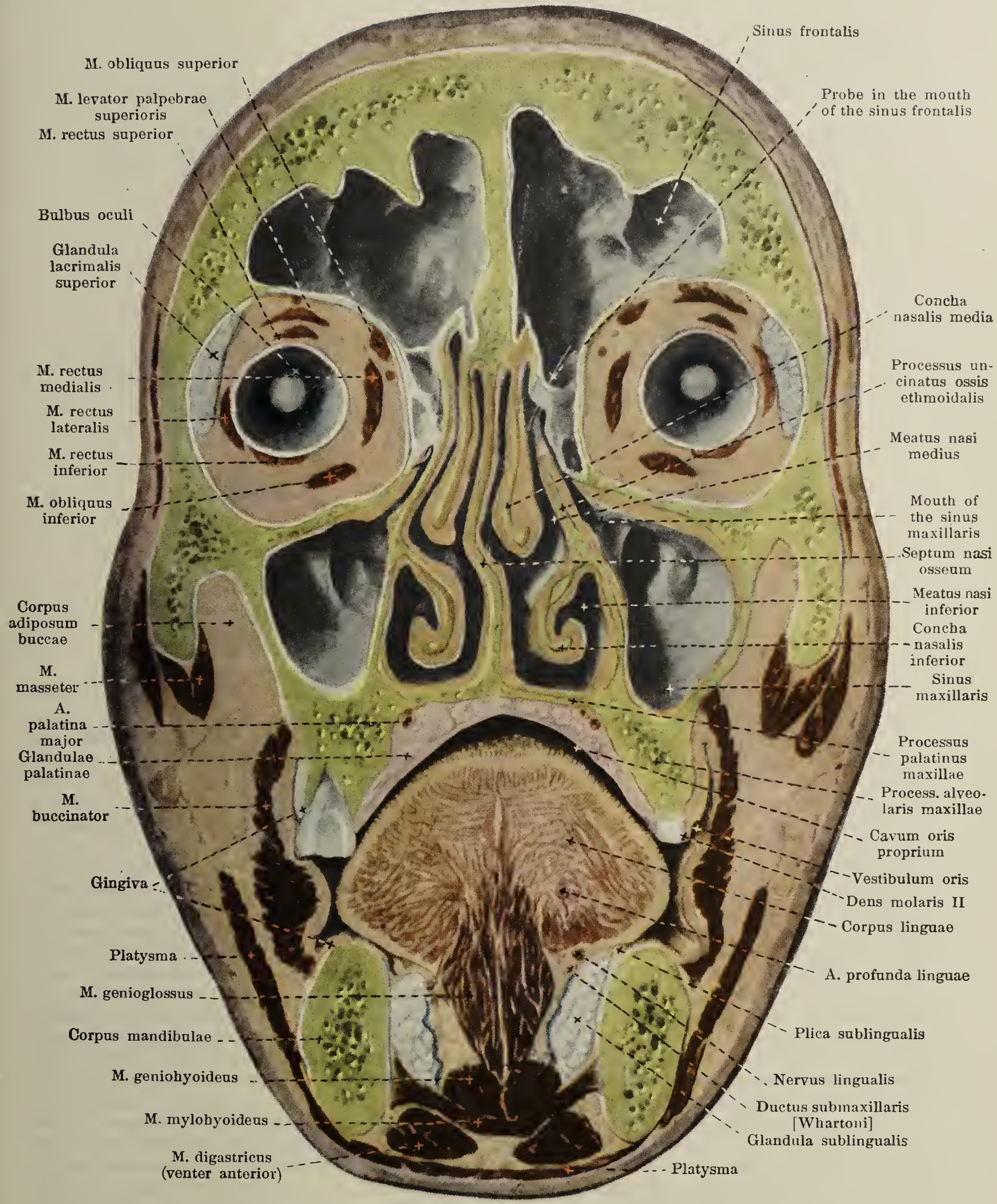
viewed from in front.

(The external skin has been completely, the musculature of the mouth-slit in large part, removed.)

The **cheeks** *(buccae)* are lined internally in the region of the vestibulum oris by the tunica mucosa oris. They contain in an upper and in a lower zone a number of *buccal glands (glandulae buccales)*, which lie usually between the mucous membrane and the m. buccinator. Attached to the latter behind the orifice of the ductus parotideus a group of somewhat larger glands *(glandulae molares)*, is usually situated on the lateral surface of the m. buccinator.



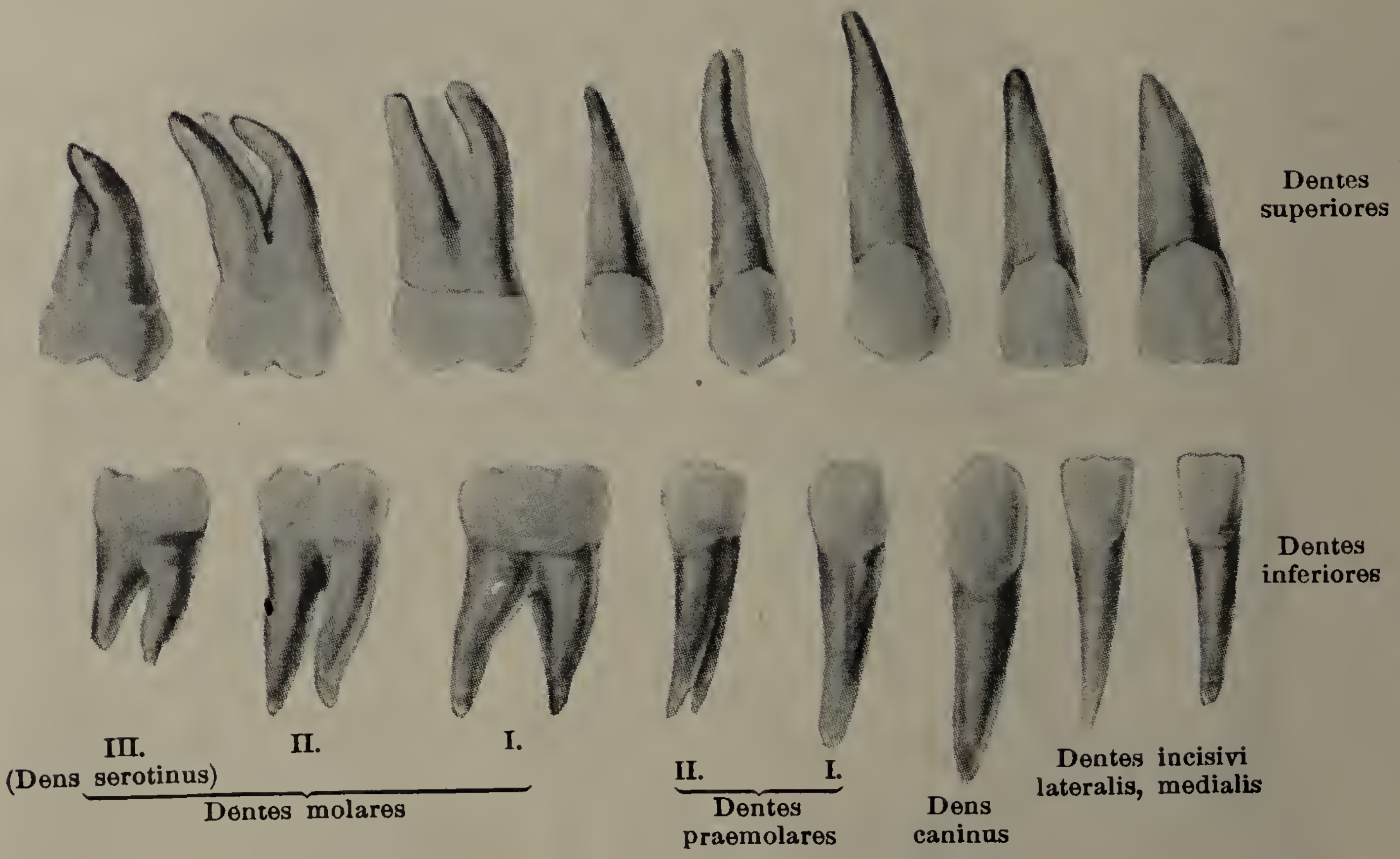
567. Median section of the head and neck, right half, viewed from the left (partly after W. Braune).



568. Frontal section of the head,
viewed from behind (after W. Braune).

(In the mandibula there are large gaps in the theeth on both sides.)

The **mucous membrane of the mouth cavity** *(tunica mucosa oris)* lines the inner surface of the lips and cheeks and is reflected upon the jaw-bones at about half the height of the roots of the teeth. It there forms the *gums (gingiva),* is high, dense, immovable and arranged around the neck of the teeth in the form of wall-like elevations (see also Figs. 574 and 594).



569. Permanent teeth, right side,

viewed from the lip or cheek surface.

The **teeth** *(dentes)* appear in two succesive series called *dentitions.* The first dentition consists of 20 ***milk teeth,*** the second of 32 ***permanent teeth,*** which appear for the most part in the place of the milk teeth.

The **permanent teeth** *(dentes permanentes)* (see also Figs. 570—572, 578—580) are present in the upper and lower jaws, eight on each side: *2 incisor teeth, 1 canine tooth, 2 premolar teeth* and *3 molar teeth.*

The ***incisor teeth (dentes incisivi)****) possess a crown which in general resembles a chisel so that its free end is formed by a straight edge, the cutting edge. The facies contactus (facies medialis et lateralis) are approximately triangular, the facies labialis et lingualis are somewhat narrowed toward the root. The labial surface is approximately quadrangular and possesses usually three low longitudinal ridges, which correspond, when the teeth have freshly broken through, to three rounded jags on the cutting edge. The lingual surface is more triangular and markedly concave lengthwise; it ends at the neck in a very blunt projection. Each incisor tooth has only one root, which is inclined somewhat lateralward ("root characteristic"). The roots are conical, compressed somewhat from right to left (more markedly in the lower teeth) and usually slightly grooved on the medial and lateral surfaces. The root canal (see Figs. 574 and 576) is single. The superior medial incisor tooth is the largest, then follow usually the superior lateral, the inferior lateral and the inferior medial, which is always the smallest.

The ***canine teeth (dentes canini)*** are the strongest and longest teeth with one root. The crown runs out at the free end into an edge, the medial shorter portion of which forms an obtuse angle with the lateral longer portion. The labial surface is approximately pentangular and is broadest between the two terminal points of the cutting edge. It is markedly convex, especially in transverse direction. The lingual surface of the upper canine tooth presents a blunt nodule on its neck, from which a strong longitudinal ridge extends to the medial angle of the chewing edge. Medial and lateral from this ridge lies a shallow groove. The lingual surface of the inferior canine tooth is slightly hollowed; its nodules project only a little or not at all. The crown of the inferior canine is the narrower and longer. The roots are single, flattened and grooved, like those of the incisor teeth; that of the inferior is not seldom bifurcated; they are inclined somewhat backward, specially toward the apex. The root canal is single.

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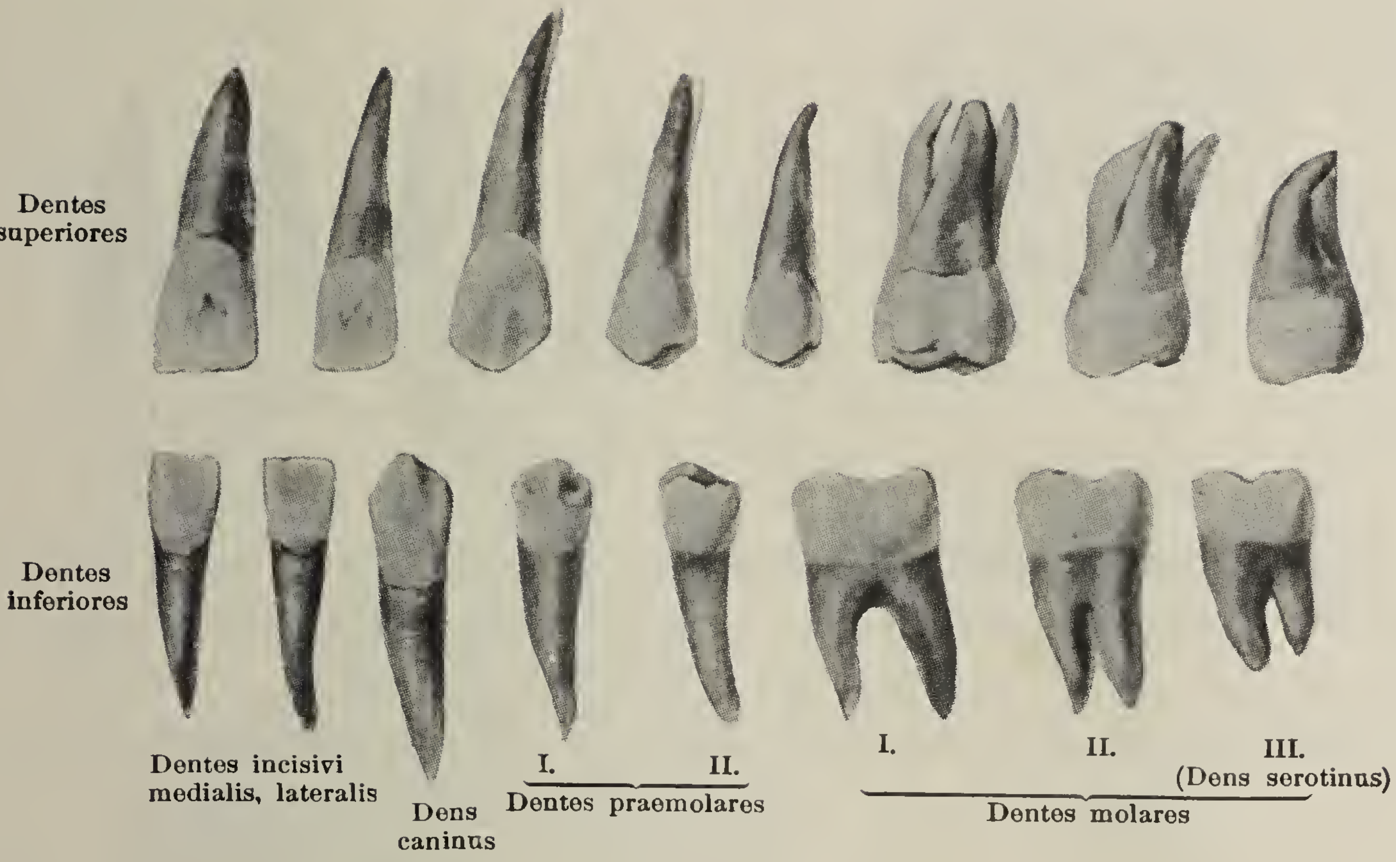
*) For the description of the teeth see also ps. 505 and 506.

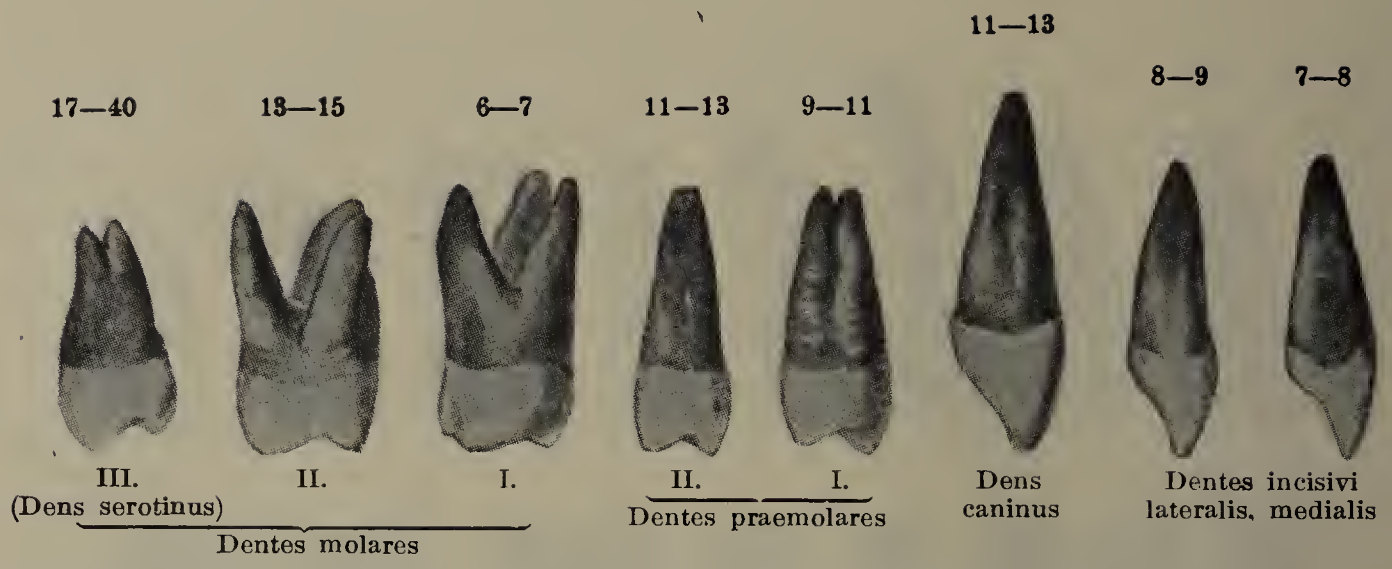


570. Permanent teeth, right side,

viewed from the lingual surface.

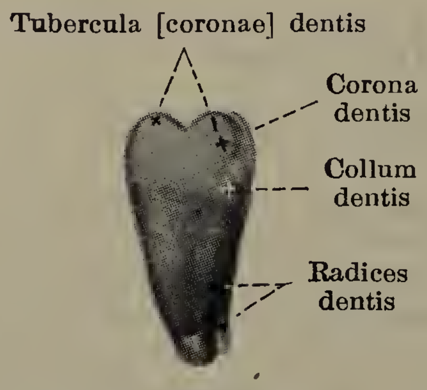
The ***premolar teeth*** *(dentes praemolares)* possess a broad, uneven, rounded-off quadrangular chewing-surface, which is divided by a groove running from before backward into a larger, buccal and a smaller, lingual tubercle; the tubercles are of the same height on the second superior premolar tooth, on the other premolars the lingual tubercle is lower. On the inferior teeth the two tubercles are frequently connected by a ridge of enamel. The buccal and lingual surfaces are convex transversely and longitudinally and each of them helps to form one of the declivities of the tubercles mentioned; thus the buccal surface resembles in its form that of the corresponding canine tooth. The root is single and curved backward; on the upper teeth it is flattened from before backward and presents flat grooves on the anterior and posterior surfaces, the marked development of which leads frequently to a bifurcation of the root of the first superior premolar tooth; the roots of the inferior teeth are more rounded. The pulp-cavity is a narrow slit-like space, compressed from before backward, and possesses two diverticula corresponding to the two tubercles; the first superior premolar tooth has, almost constantly, two root canals, one buccal and one lingual, the other have one slit-like canal (see also p. 505).

The ***molar teeth*** *(dentes molares)* are the strongest teeth and have (especially in the lower jaw) a more cubical crown. On the first superior molar tooth the chewing-surface is rhombic and divided by an H-like asymmetrically arranged groove into four tubercles of unequal size, of which two lie upon the buccal surface and two upon the lingual surface; the anterior lingual tubercle is the largest, the posterior the smallest. The buccal and lingual surfaces are convex and are subdivided by a longitudinal groove; the lingual surface frequently possesses a small (fifth) tubercle in front; it is often merely indicated and only very rarely reaches the chewing-surface. The anterior and posterior surfaces (facies contactus) are convex. The second upper molar tooth has either four tubercles like the first, or only three, in which case the posterior lingual tubercle is merely indicated or entirely absent. The third upper molar tooth *(dens serotinus, wisdom tooth)* varies extremely in form and size. The crown in many ways resembles that of the second; it possesses usually three tubercles, sometimes more, sometimes fewer; it may by very much reduced in size. The upper molar teeth have three roots; the two buccal roots run approximately parallel to one another, are flattened from before backward and bend somewhat backward at the apex; the third, lingual (palatal) root is rounded and diverges from the other two. The buccal roots have usually anterior and posterior longitudinal grooves, the palatal root is often manifoldly grooved on its lingual surface. The roots of the wisdom tooth are more or less fused with one another. The pulp cavity of the upper molar teeth is large, somewhat narrowed from before backward and possesses as many processes as there are nodules present (3—4). Each root has a single canal. The first molar tooth is usually the largest, the third the smallest.

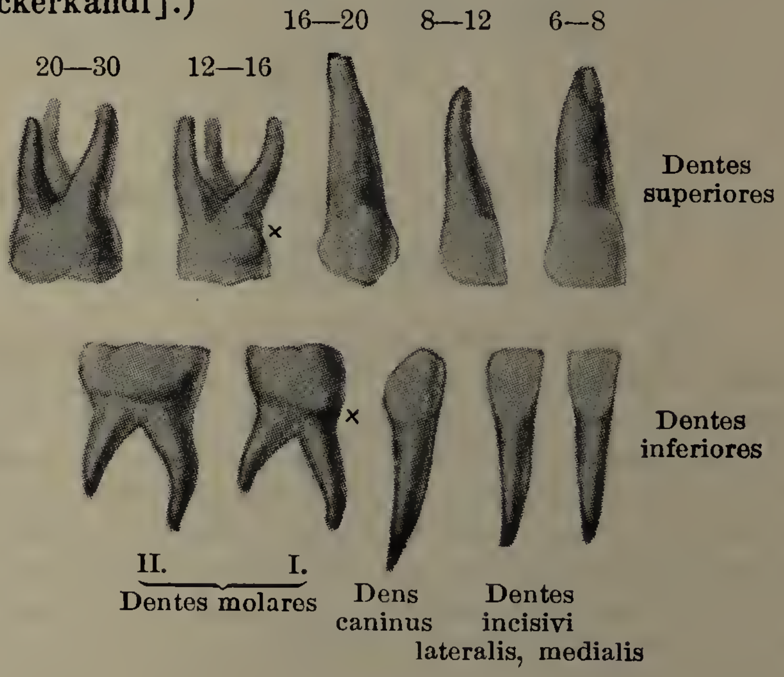


571. Upper permanent teeth, right side, facies contactus; the anterior teeth viewed from the lateral surface, the posterior teeth from the posterior surface.

(The Arabian numerals give the time of eruption of the individual teeth in years [after E. Zuckerkandl].)



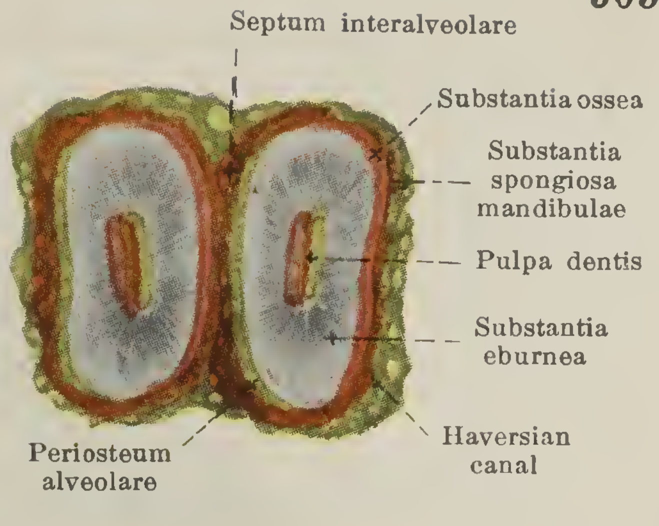
572. First inferior permanent molar tooth, right side, viewed from in front.



573. Milk teeth, right side, viewed from the labial or buccal surface.

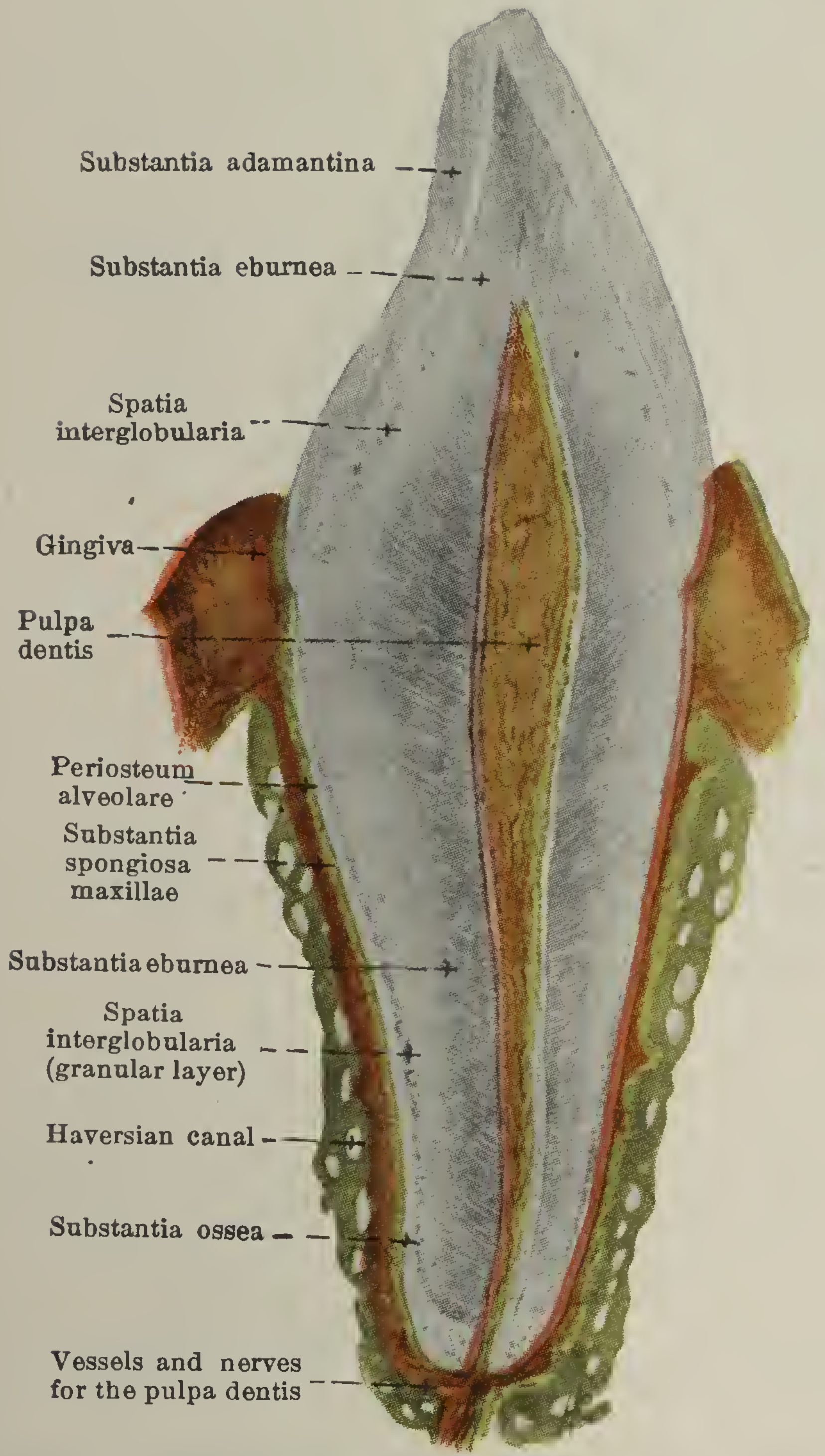
(The Arabian numerals give the time of eruption of the individual teeth in months [after Fr. Hesse].)

The ***molar teeth*** (continued). The inferior molar teeth are larger and more powerful than the superior. Their chewing-surfaces are rectangular and are somewhat longer from before backward than in the frontal direction. Each surface is divided by a fairly symmetrical +-shaped groove into 4—5 tubercles, namely 2—3 buccal and 2 lingual, of which the latter are a little higher; the anterior tubercles are somewhat larger than the posterior. The buccal surface is more markedly convex than the lingual. The first molar tooth almost always presents five tubercles, the second usually four, often five. The third *(wisdom tooth)* varies very much, but in general is not so rudimentary as in the upper jaw; it has usually 5 or 4 tubercles. The inferior molar teeth possess two roots, an anterior broader and a posterior; both are flattened from before backward and usually present longitudinal grooves on the broad anterior and posterior surfaces. The anterior root is usually directed vertically, the posterior obliquely backward; either of these may be bifurcated. The roots of the wisdom teeth are very different, frequently fused. The pulp cavity (see Fig. 577) resembles in shape that of the crown. The anterior root usually has two canals, a buccal and a lingual, the posterior usually only one (sometimes also two) (see also p. 505). The wisdom tooth presents three or two root canals or even only one. The first molar tooth is usually the largest, the third the smallest.



575. Transverse section through the roots of two lower incisor teeth and their surroundings.

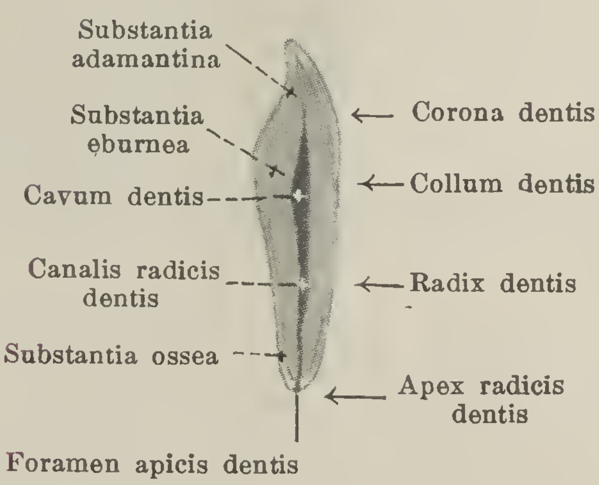
Magnification: 5 : 1.



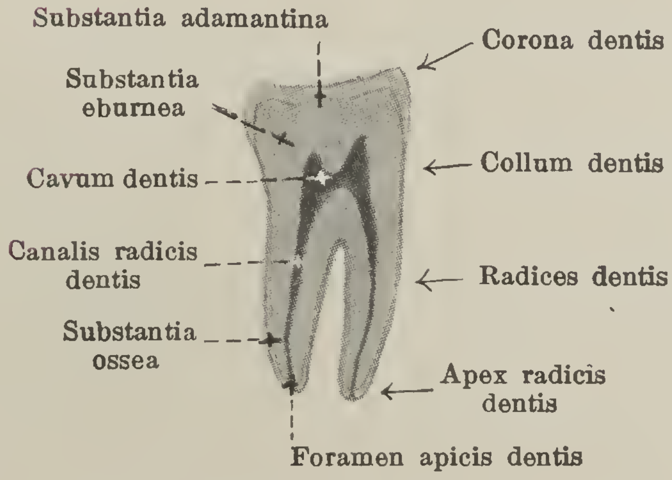
574. Sagittal section of an upper incisor tooth and its surroundings.

Magnification: 5 : 1.

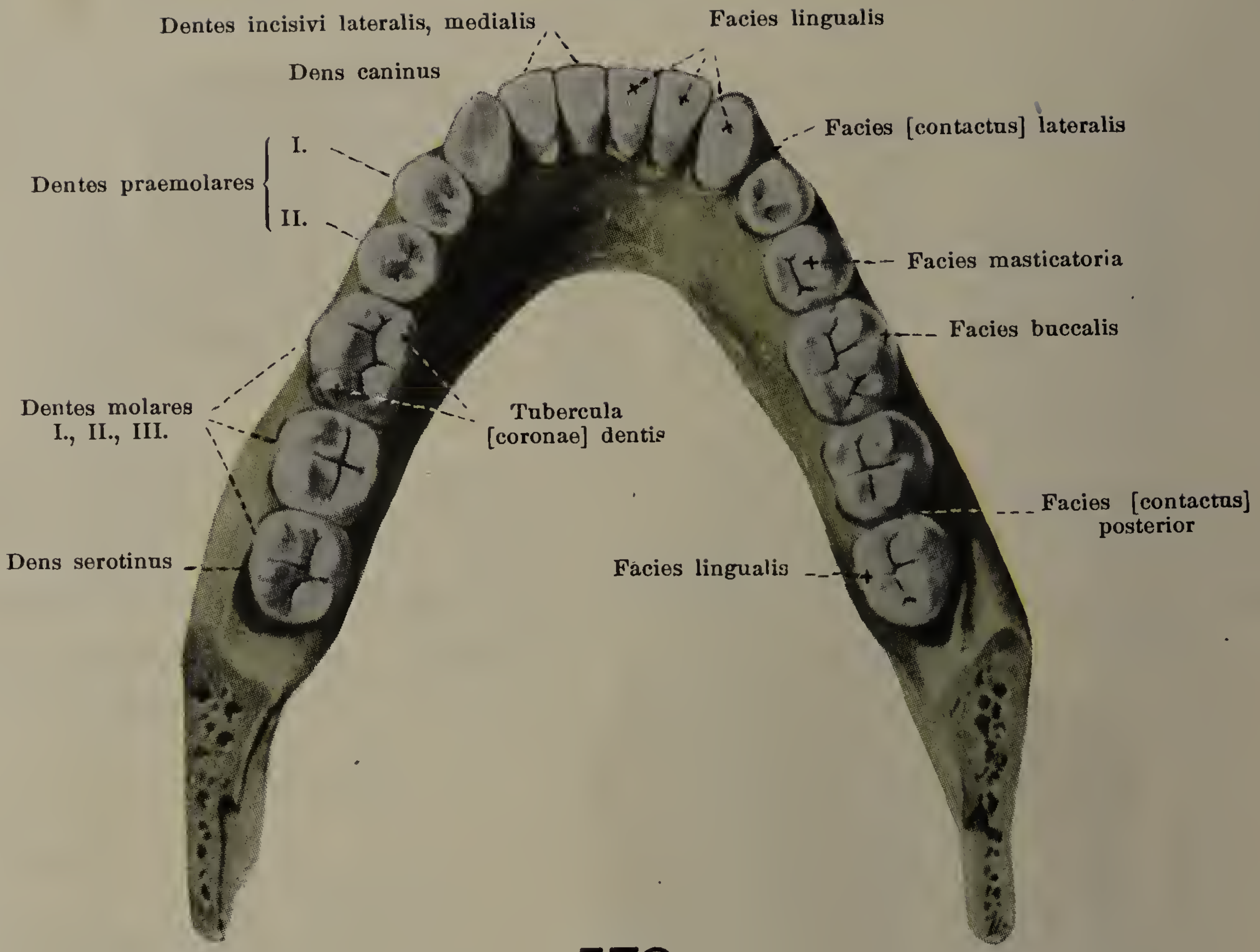
(In Figs. 574 and 575 the drawings of the teeth have been made from air-containing ground sections.)



576. Sagittal section through an upper incisor tooth.



577. Sagittal section through a lower molar tooth.



578.

Permanent teeth of the lower jaw *in situ,* viewed from above.

(The rami mandibulae have been sawed away.)

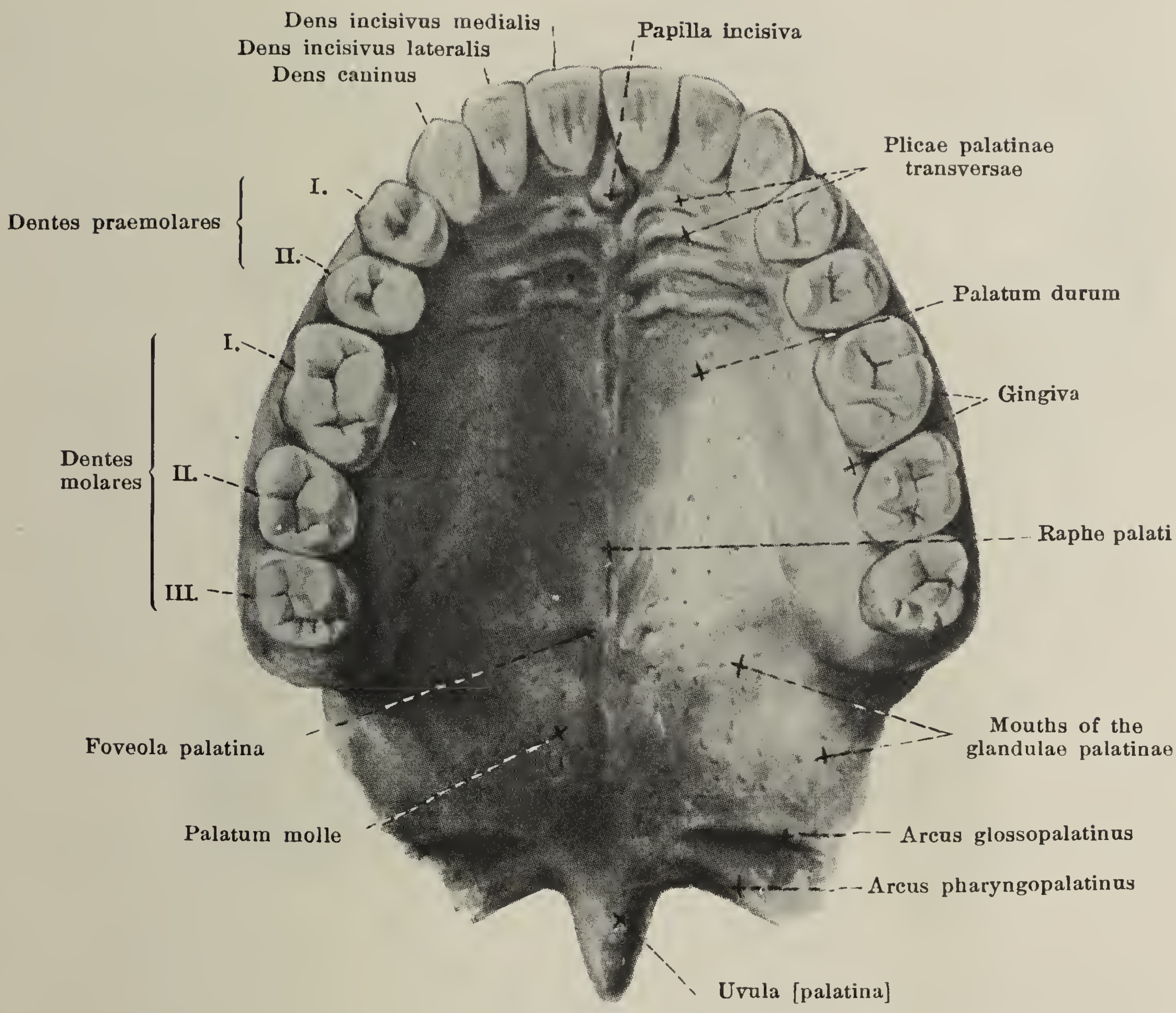
The **milk teeth** ***(dentes decidui)*** (see Fig. 573) are situated in the upper and lower jaw, five on each side as follows: *2 incisor teeth*, *1 canine tooth* and *2 molar teeth.*

With the exception of the first molar teeth, in the main they resemble in form the corresponding permanent teeth, but are, however, in general smaller and more delicate. The crowns of the incisor and canine teeth are relatively broader and shorter, their roots are fairly long and very delicate. The milk teeth stand more perpendiculary in the jaws. Especially characteristic is the markedly developed ridge-like enamel border with which the crown is marked off from the root.

The ***incisor milk teeth*** are in their crowns very similar to the permanent. The root of the upper medial one is somewhat flattened from before backward, that of the others is round. The "root characteristic" (see p. 500) is distinctly marked on the upper teeth, but on the lower it is inconstant.

The ***canine milk teeth*** resemble the permanent very closely; the roots are round and directed toward the first molar tooth.

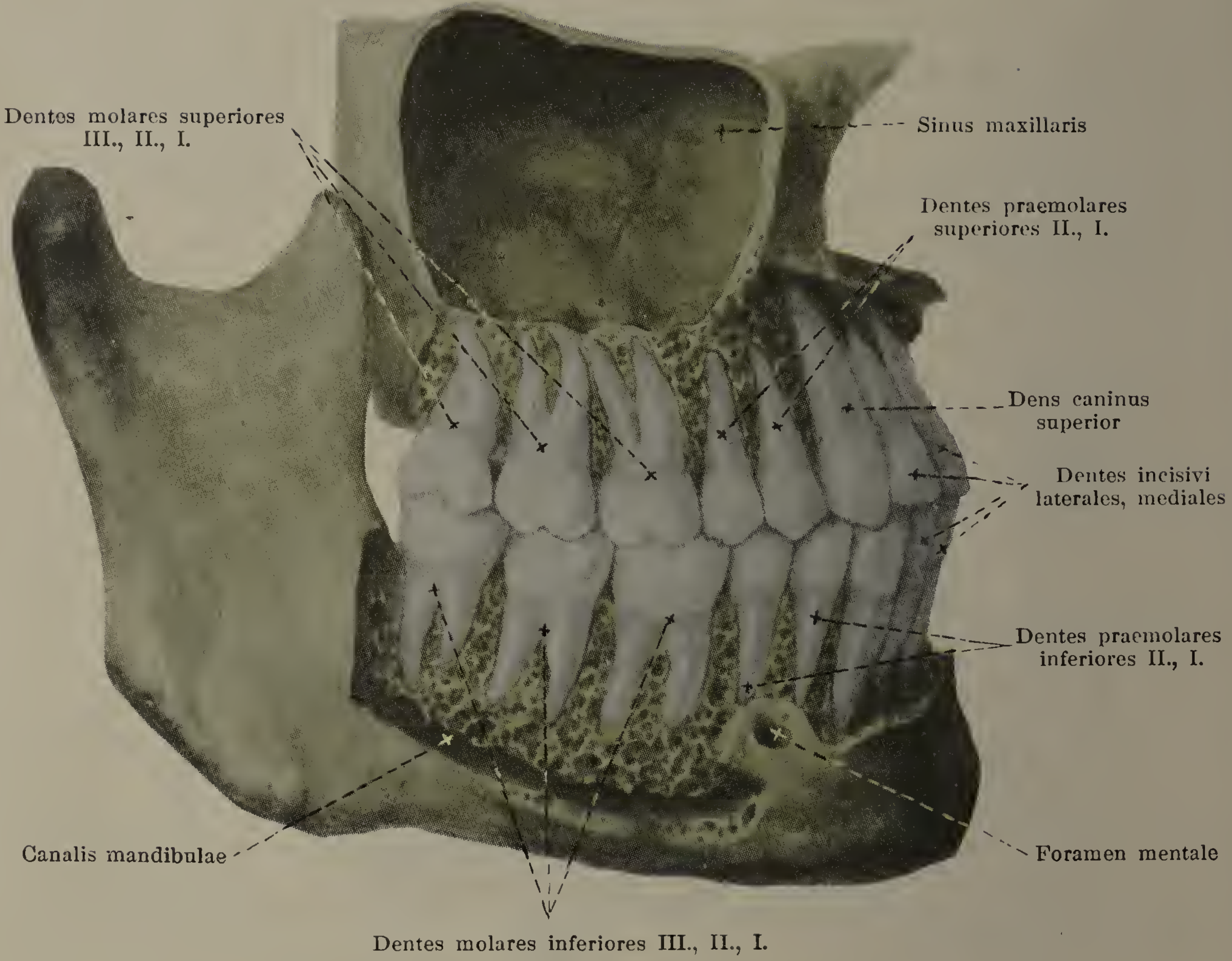
The ***molar milk teeth.*** The first upper molar tooth occurs in two forms. Either it resembles in its crown, especially in its chewing-surface, the first permanent premolar very closely, in which case the chewing-surface is triangular and divided by a sagittal groove into a buccal and a lingual tubercle; or the chewing-surface is broader from before backward, the buccal tubercle runs out more into a cutting edge, and behind the lingual tubercle a second smaller one appears. The buccam surface regularly presents a blunt nodular projection in front just over the neck of the tooth. The upper second molar milk tooth resembles throughout the first permanent upper molar tooth. Both upper molar milk teeth possess three roots, which in position and form are in general like those of the permanent teeth; but at their tips they diverge widely from one another. The first lower molar tooth has a quadrangular chewing-surface, which is drawn out lengthwise from before backward. It presents four or five tubercles, two lingual, sharp, and two or three buccal, lower, separated from the former by a sagittal furrow. The first lower tooth bears on its buccal surface a projection analogous to that seen in the first upper tooth. The second lower molar milk tooth resembles throughout the first permanent lower molar tooth. Each of the two lower molar milk teeth has two broad roots, which diverge markedly from one another, and only at their tips are bent somewhat toward one another; otherwise, however, they resemble those of the permanent teeth.



579. Permanent teeth of the upper jaw *in situ*

with the mucous membrane of the palate, viewed from below.

General statements regarding the teeth (see Figs. 572 and 574—577). Each tooth consists of *dentine (substantia eburnea)*, *enamel (substantia adamantina)* and *cement (substantia ossea)*. The dentine forms the main mass and gives the tooth its form, the enamel covers the free part of the tooth superficially, the cement the parts hidden in the bone and gum. According to form are distinguished the *crown of the tooth (corona dentis)*, the *neck of the tooth (collum dentis)*, and the *root of the tooth (radix dentis)*. The crown of the tooth is the thickest part projecting free into the mouth cavity. The root of the tooth, often multiple, is the longest portion, is situated for the most part in the correspondingly shaped alveolus of the jaw and is there held firmly in place by the fibres of the *root membrane (periosteum alveolare)* which for the most part run transversely; a narrow region of the root, however, projects beyond the free margin of the bone, is covered only by the gum and constricted more markedly in teeth with several roots than in teeth with one root; it is called the *neck of the tooth*. Within the dentine lies a cavity which resembles the external form of the tooth; the larger portion of the cavity situated in the crown and in the neck is called the *pulp cavity (cavum dentis)*; this narrows down to a slender *root canal (canalis radicis dentis)* which runs in every root and opens at the tip of the root *(apex radicis dentis)* by means of a fine opening *(foramen apicis dentis)*. The course, form and number of the root canals especially of the premolar, and of the anterior roots of the two first lower molares are not constant or regular. The canals of the same root are often at different levels connected with each other by fine or coarse anastomoses. Near the tip of the root, the canals may be branched into two or more canaliculi which open apart at the tip. The whole tooth cavity is completely filled by the *tooth pulp (pulpa dentis)*, rich in blood vessels and nerves.

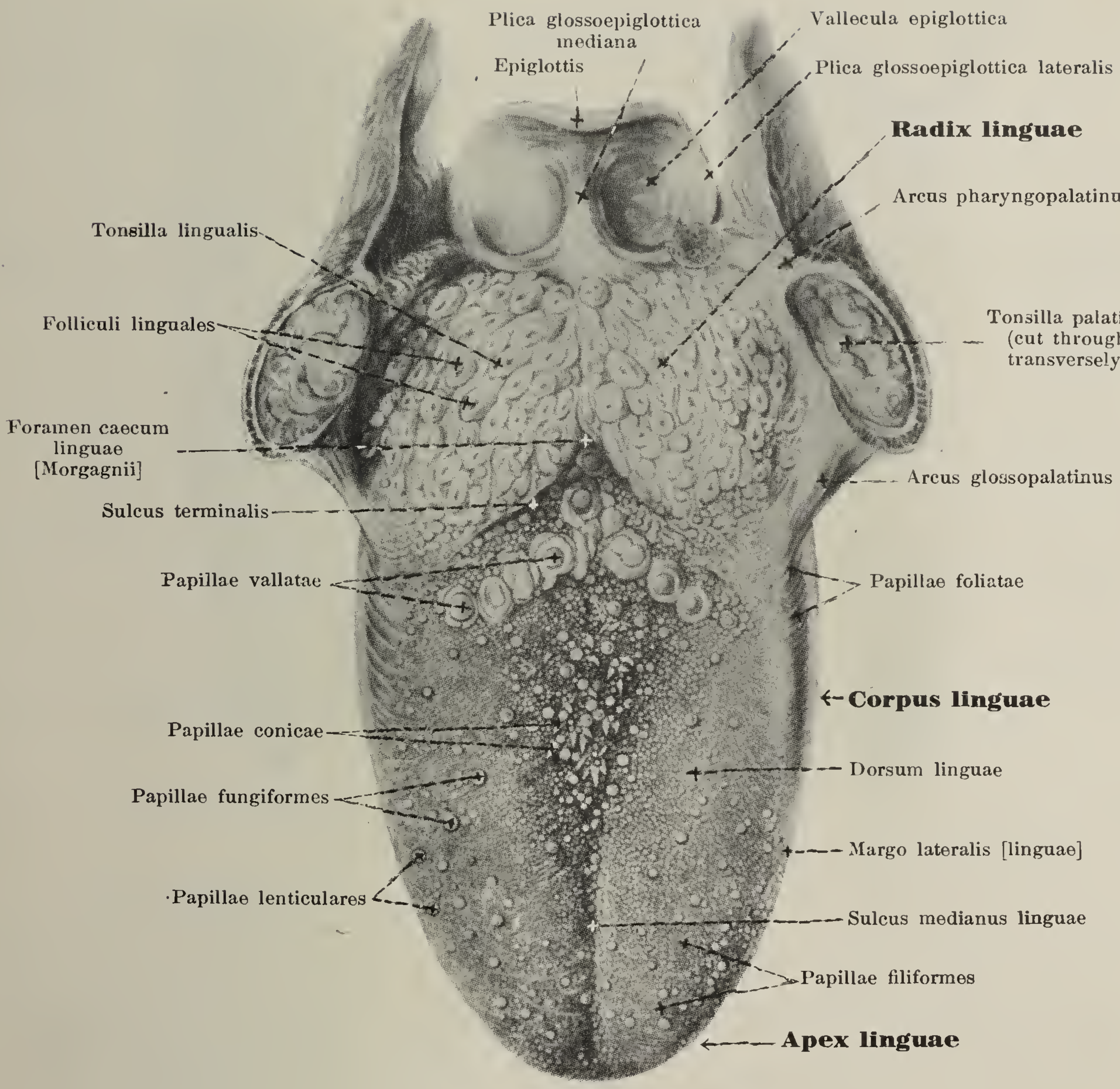

Dentes molares superiores III., II., I.
Sinus maxillaris
Dentes praemolares superiores II., I.
Dens caninus superior
Dentes incisivi laterales, mediales
Dentes praemolares inferiores II., I.
Canalis mandibulae
Foramen mentale
Dentes molares inferiores III., II., I.

580. The permanent teeth, viewed from the right.

(The external layer of bone has been partly removed and the sinus maxillaris has been opened.)

On the *crown of the tooth* (see Fig. 578) five surfaces can be distinguished. The external surface of the incisor and canine teeth is covered by the lips *(facies labialis),* of the premolar and molar teeth by the cheeks *(facies buccalis).* The inner surface belonging to the concave side of the tooth-arch is the *facies lingualis.* The two surfaces, by which the tooth touches its neighbors are called the *facies contactus* and on the incisor and canine teeth are distinguished as the *facies medialis* and *facies lateralis*, on the premolar and molar teeth as the *facies anterior* and *facies posterior.* The fifth surface *(facies masticatoria)* when the jaws are closed is in contact with the corresponding surface of the other row of teeth; on the incisor teeth it is reduced to a cutting edge, but on the other teeth it has one or several tubercles *(tubercula [coronae] dentis).*

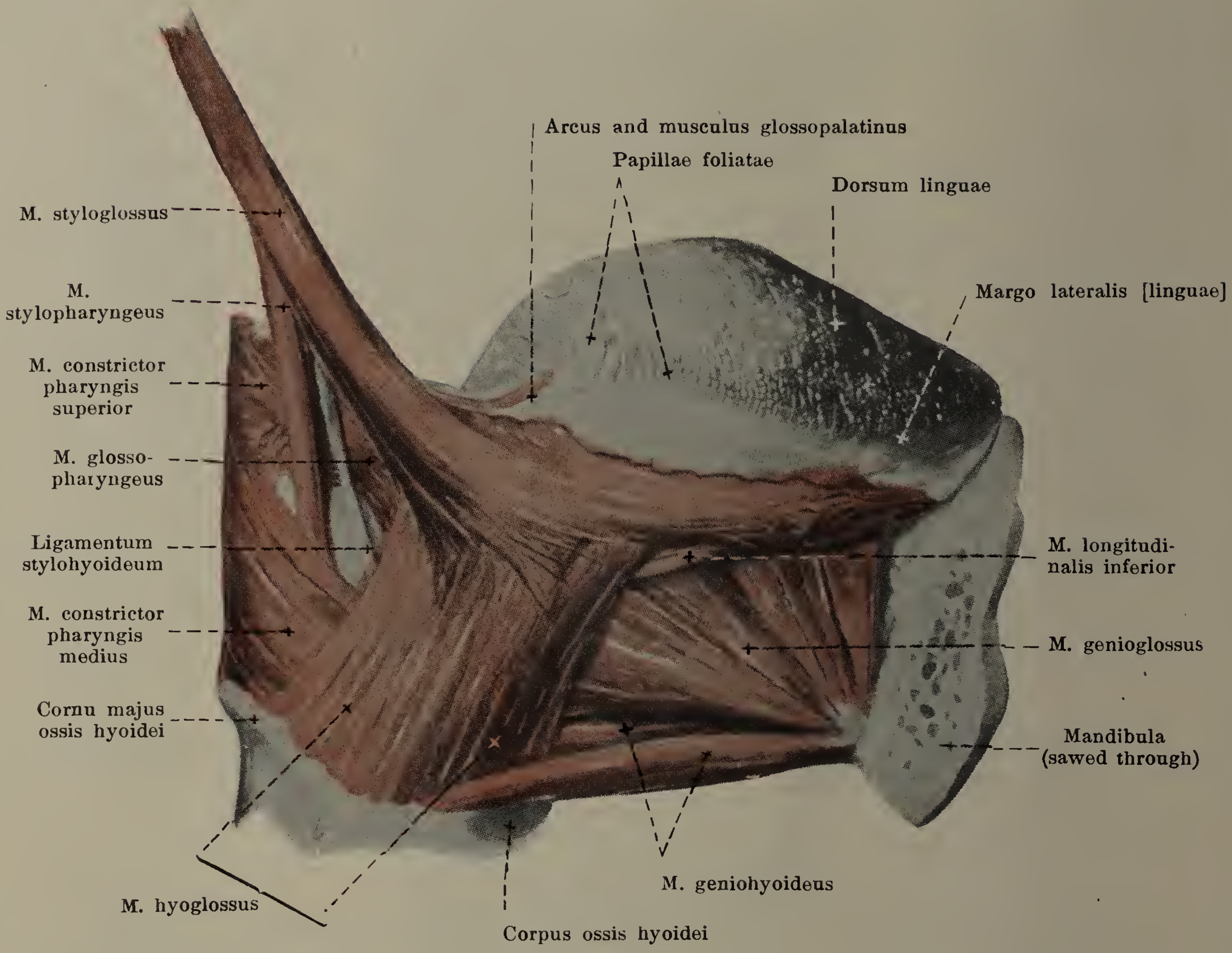
The *lower* **row of teeth** or *tooth-arch (arcus dentalis inferior)* (see Fig. 578) resembles a parabola in its curvature, the *upper row (arcus dentalis superior)* (see Fig. 579) forms half an ellipse. Since the two rows of teeth differ from one another and since, besides, the teeth in the two jaws present differences in form and size, the teeth of the same name in the upper and lower jaws do not come into contact with one another in their corresponding portions. The *articulation of the rows of teeth* occurs rather as follows: The upper teeth which *in toto* are directed with their long axes somewhat obliquely outward and downward, project lateralward somewhat over the lower teeth, the long axes of which run more inward and upward. As a result of this the upper anterior teeth cover somewhat the free ends of the lower teeth from in front (the upper teeth bite over the lower) (see also Fig. 567), while the buccal tubercles of the other upper teeth lie somewhat lateralward as regards the same tubercles of the lower teeth, and the lingual tubercles of the upper teeth lie in the grooves between the buccal and lingual tubercles of the lower teeth. The rows of teeth are also displaced from before backward as regards one another. Especially since the upper incisor teeth are considerably broader than the lower, the upper canine tooth lies between the lower canine and the lower first premolar, touching both; similarly the upper premolar and molar teeth are displaced backward; the upper wisdom tooth, smaller than the lower, is the only one that does not project over behind the lower.



581. Tongue, viewed from above.

(The palatine arches and the palatine tonsils have been cut through transversely.)

The **tongue** *(lingua)* is a flat, oblong body consisting mainly of muscles and is fastened below to the floor of the mouth. It ends in front in a flat rounded tip *(apex linguae).* Following upon this without being sharply differentiated from it is the body of the tongue, *corpus linguae.* This in turn is bounded behind by the *sulcus terminalis,* the right and left limbs of which run obliquely backward toward the median plane and meet in the *foramen caecum linguae [Morgagnii];* the latter is represented usually by a small depression and in an early embryonal period is the opening of the ductus thyreoglossus (see p. 592), the terminal portion of which may still be met with in variable length in the adult as the *ductus lingualis* (see Fig. 567). The region behind the sulcus terminalis is called the *radix linguae* (root of the tongue). The upper surface of the tongue *(dorsum linguae)* (see also Figs. 567 and 568) is curved in a sagittal and frontal direction so as to be convex upward and presents in the median plane especially in front a shallow groove, the *sulcus medianus linguae.* At the root of the tongue it goes directly over into the medial surface of the palatine arches and the tonsils (see also Fig. 596). The body of the tongue is bounded lateralward by the blunt *margo lateralis [linguae].* The inferior surface *(facies inferior [linguae])* lies free only along its lateral margins and below the anterior portion of the tongue (see also Figs. 567, 568 and 589).


Arcus and musculus glossopalatinus
Papillae foliatae
Dorsum linguae
M. styloglossus
M. stylopharyngeus
Margo lateralis [linguae]
M. constrictor pharyngis superior
M. glossopharyngeus
Ligamentum stylohyoideum
M. longitudinalis inferior
M. constrictor pharyngis medius
M. genioglossus
Cornu majus ossis hyoidei
Mandibula (sawed through)
M. geniohyoideus
M. hyoglossus
Corpus ossis hyoidei

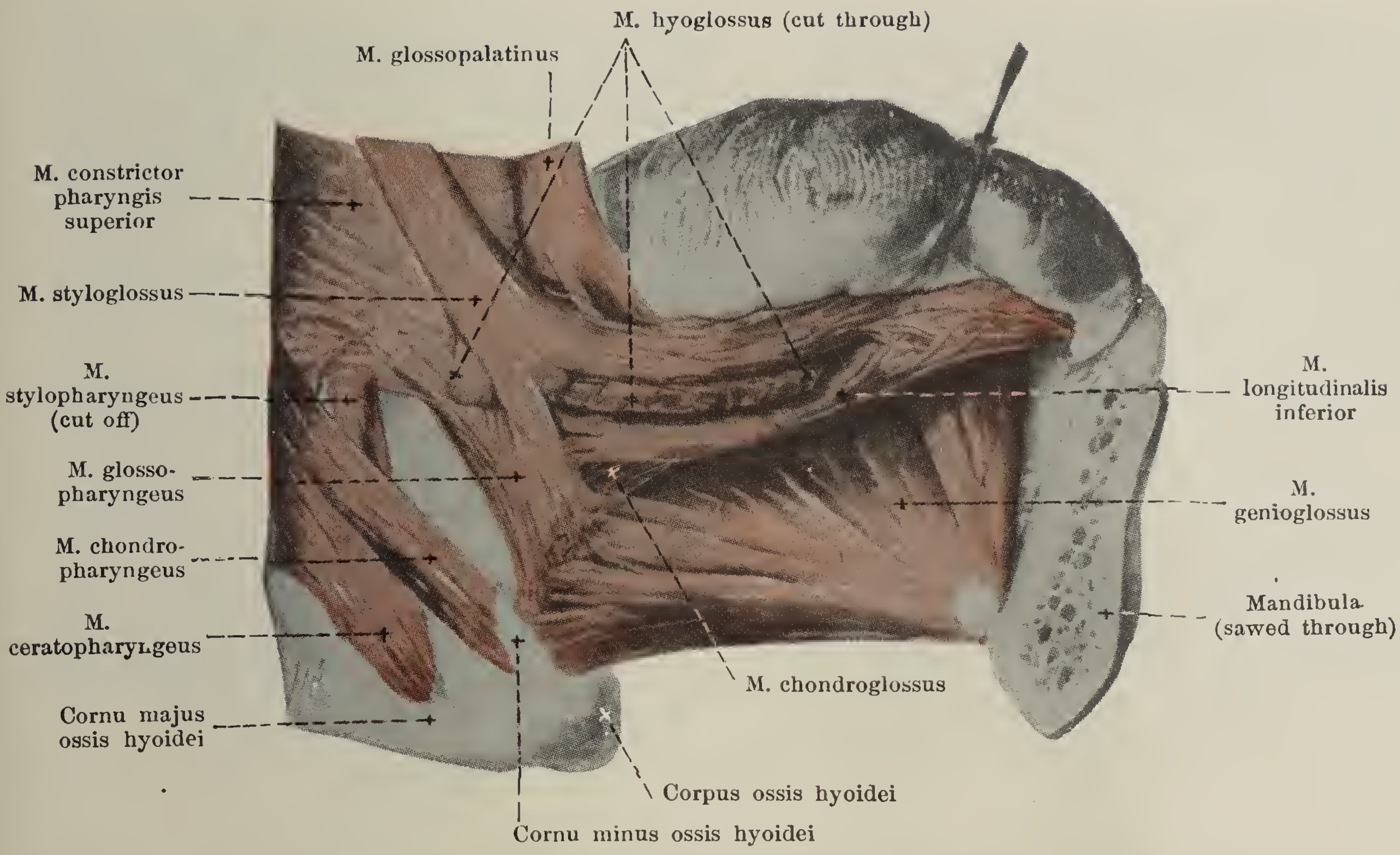
582. Musculature of the tongue, viewed from the right.

(The right half of the lower jaw, the m. mylohyoideus and the salivary glands have been removed.)

Muscles of the tongue ***(musculi linguae):***

M. styloglossus (see also Figs. 583, 585, 590 and 606). Form: long, narrow and flat. Position: medianward from and above the m. stylohyoideus, between the a. carotis externa and interna, medianward from the mandibula and m. pterygoideus internus, covered by the glandula parotis. Origin: processus styloideus and ligamentum stylohyoideum. Insertion: it runs obliquely downward, forward and medianward to the lateral surface of the m. hyoglossus. It there divides into two bundles; the larger, lateral, upper bundle goes on the lateral surface of the m. hyoglossus and m. longitudinalis inferior beneath the lateral margin of the tongue toward the tip of the tongue; the smaller, medial, inferior bundle perforates the m. hyoglossus and turns medianward in the posterior part of the tongue. Action: it draws the tongue, especially the radix linguae, upward and backward. Innervation: n. hypoglossus.

M. hyoglossus (see also Fig. 583). Form: flat, quadrangular. Position: medianward from and above the glandula submaxillaris and m. mylohyoideus, medianward from the mandibula. Origin: upper margin of the corpus and cornu majus ossis hyoidei. Insertion: it extends upward and somewhat forward and plunges between the bundles of the m. styloglossus; the fibres then bend around forward between the lateral bundle of the m. styloglossus and the m. longitudinalis inferior and run longitudinally in the tongue toward the apex. Action: it draws the tongue backward and downward. Innervation: n. hypoglossus.


M. hyoglossus (cut through)
M. glossopalatinus
M. constrictor pharyngis superior
M. styloglossus
M. stylopharyngeus (cut off)
M. glosso-pharyngeus
M. chondro-pharyngeus
M. ceratopharyngeus
Cornu majus ossis hyoidei
Cornu minus ossis hyoidei
Corpus ossis hyoidei
M. chondroglossus
M. longitudinalis inferior
M. genioglossus
Mandibula (sawed through)

583. Deep musculature of the tongue,

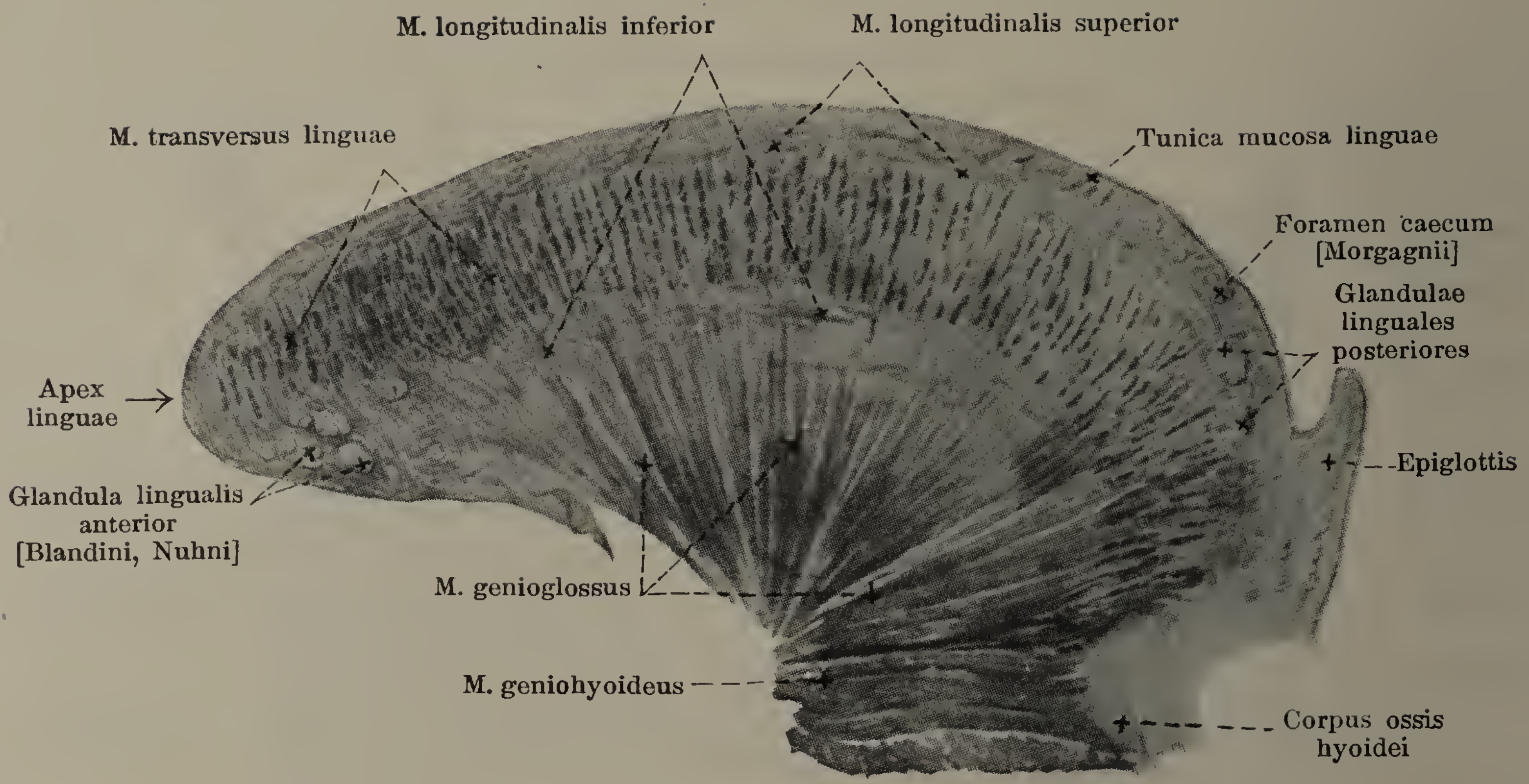
viewed from the right.

(As in Fig. 582; in addition the mm. geniohyoideus and hyoglossus have been removed and the tongue has been drawn upward and to the left.)

M. genioglossus (O. T. geniohyoglossus) (see also Figs. 582, 584, 585 and 590). Form: approximately quadrangular, thick, placed sagittally. Position: in the depth of the tongue, just above the m. geniohyoideus, close to and parallel to the median plane, separated from the muscle of the other side only by loose connective tissue and by the septum linguae (see p. 511); lateralward partly covered directly by the mm. longitudinalis inferior, hyoglossus, styloglossus and the glandula sublingualis. Origin: by a small triangular tendon from the spina mentalis mandibulae, just above the m. geniohyoideus. Insertion: the fibres diverge backward and upward. The lowermost fibres go backward parallel to the m. geniohyoideus and are attached partly to the corpus ossis hyoidei, partly to the epiglottis; the other fibres radiate fan-like toward the dorsum linguae in the whole length of the tongue and accordingly decussate in layers with the fibres of the m. transversus linguae. Action: it draws the tongue forward and downward. Innervation: n. hypoglossus.

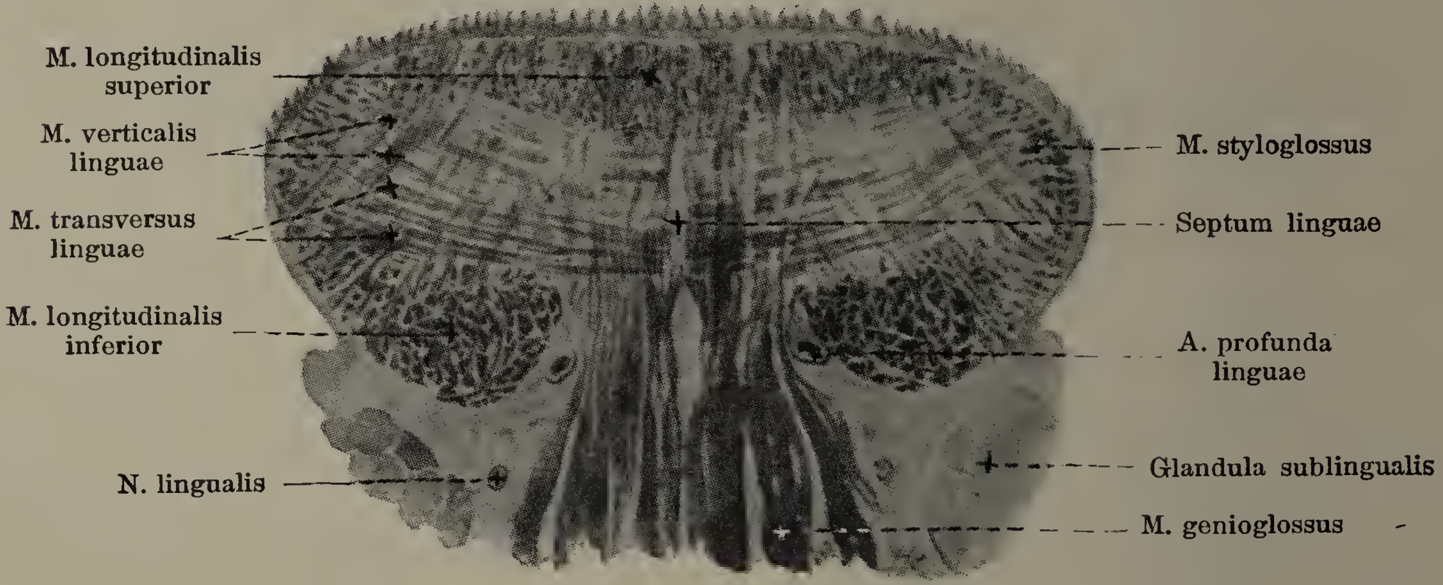
M. longitudinalis inferior (O. T. inferior lingual) (see also Figs. 582, 585 and 590). Form: long and narrow. Position: in the depth of the tongue, in front between the mm. genioglossus and styloglossus, behind between the mm. genioglossus and hyoglossus. Origin: in the mucous membrane of the root of the tongue. Insertion: the fibres pass downward in the form of a curve and collect on the medial surface of the m. hyoglossus in the form of a well isolated muscle-belly. Fibres which arise from the cornu minus oss. hyoidei *(m. chrondoglossus)* partly lie upon this muscle-belly below, partly extend upward and forward between the bundles of the m. genioglossus and join the m. longitudinalis superior. The main mass of the m. longitudinalis inferior runs straight forward and ends in the mucous membrane of the facies inferior linguae; only a small part bends upward to the mucous membrane of the dorsum of the tongue. Action: it shortens the tongue in the longitudinal direction. Innervation: n. hypoglossus.

M. longitudinalis superior (O. T. superior lingual) (see Figs. 584—586), just beneath the mucous membrane of the whole dorsum of the tongue, strengthened behind by a part of the fibres of the m. chondroglossus. The fibres run in the longitudinal direction, are stretched out in bundles in short arches, concave above, between points of the mucous membrane, the different bundles decussating with one another. Action: it bulges the tongue upward in the longitudinal direction. Innervation: n. hypoglossus.


M. longitudinalis inferior
M. longitudinalis superior
M. transversus linguae
Tunica mucosa linguae
Foramen caecum [Morgagnii]
Glandulae linguales posteriores
Apex linguae
Epiglottis
Glandula lingualis anterior [Blandini, Nuhni]
M. genioglossus
M. geniohyoideus
Corpus ossis hyoidei

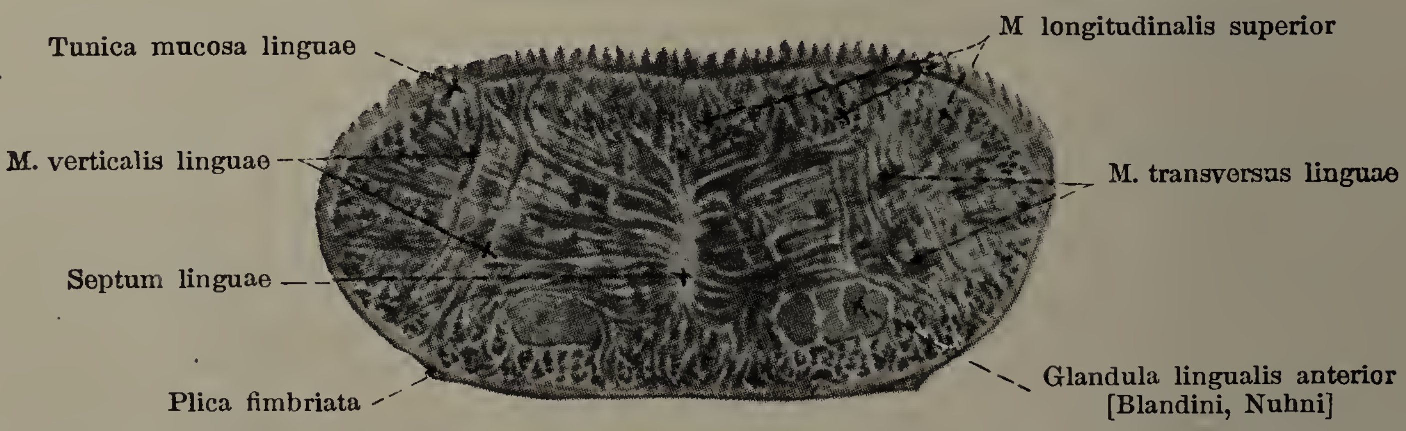
584. Sagittal section through the tongue

of a new-born babe, near the median plane. Magnification: circa 3:1.



585. Frontal section through the body of the tongue

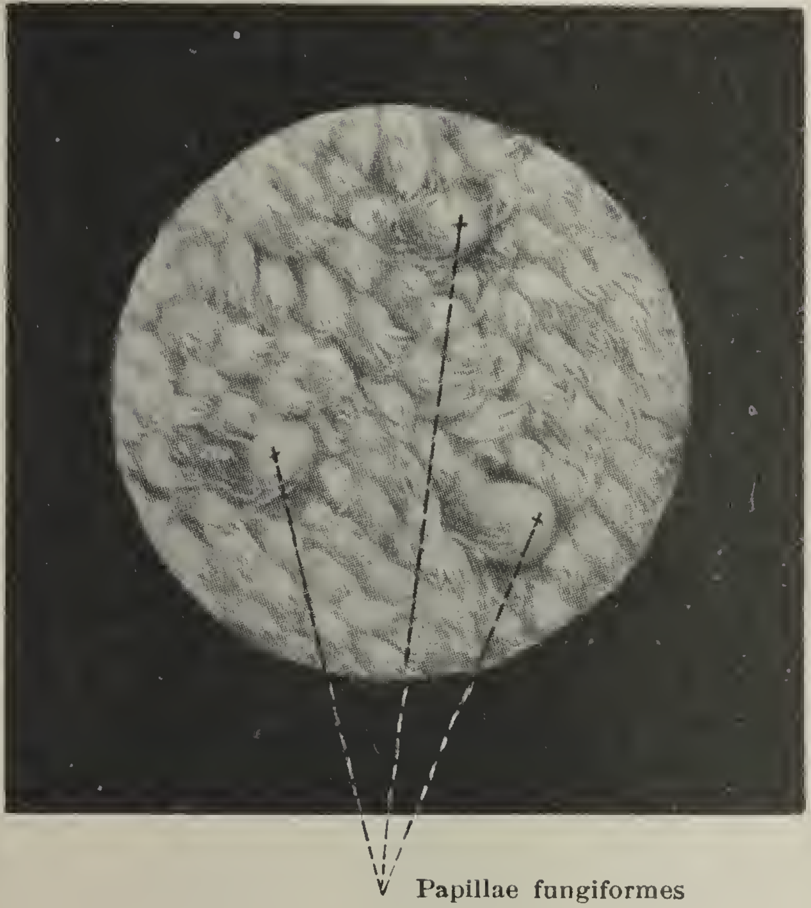
of a new-born babe. Magnification: circa 3:1.



586. Frontal section through the apex of the tongue

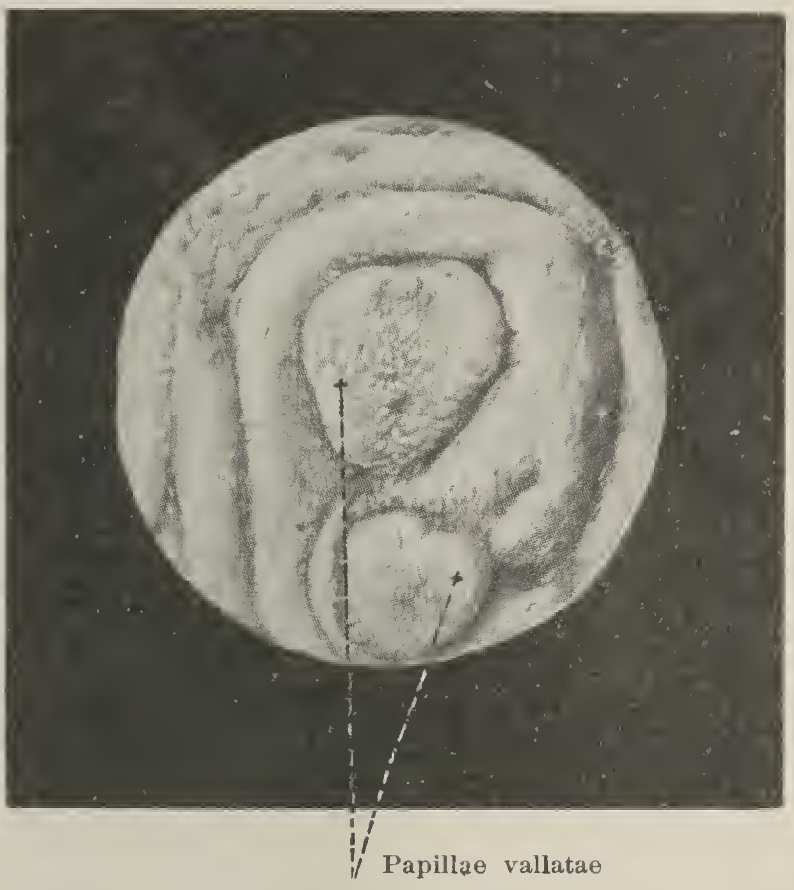
of a new-born babe. Magnification: circa 3:1.

(Figs. 584—586 after preparations of Fr. Hesse.)



587. Papillae filiformes,

viewed from the surface.



588. Papillae vallatae,

viewed from the surface.

Magnification: 7:1.

M. transversus linguae (see Figs. 584—586), in the whole extent of the tongue. It consists of layers placed perpendicularly to the surface alternating with the lamellae of the m. genioglossus; in these layers the fibers run in a frontal direction and in a fan-like distribution to the mucous membrane of the dorsum and lateral margin of the tongue; some of the fibres of the muscle arise from the septum linguae, others perforate it. Action: it bulges the tongue upward in the transverse direction. Innervation: n. hypoglossus.

M. verticalis linguae (see Figs. 585 and 586) is formed of bundles of fibres, which pass directly from the superior to the inferior mucous membrane of the tongue especially in the neighborhood of its lateral margin. Innervation: n. hypoglossus.

Septum linguae (see Figs. 567, 585 and 586) is a small, narrow leaf of connective tissue which runs from before backward in the median plane and is surrounded on all sides by muscles; it is curved in a zigzag fashion to the right and to the left and multiply perforated.

The **tunica mucosa linguae** *(mucous membrane)* (see Fig. 581) is covered on the dorsum of the tongue by small elevations, the *papillae linguales (papillae of the tongue).* These are:

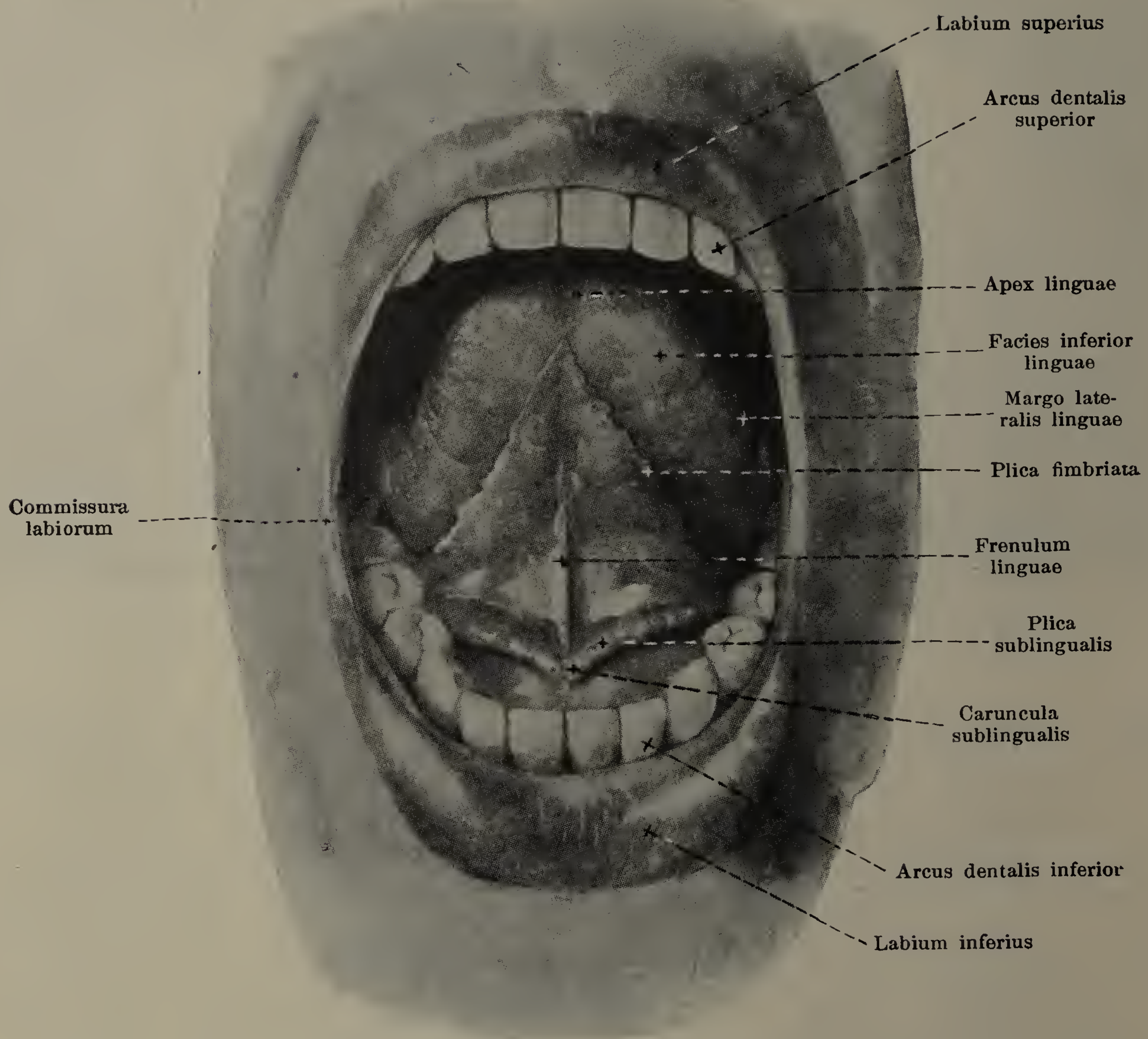
1. *Papillae filiformes,* narrow wedge-shaped elevations, with brush-like epithelial appendages of whitish color, present on the whole of the dorsum of the tongue, on its lateral margins, and at its tip. They are most dense in the middle part of the dorsum a little in front of the papillae vallatae and lie on the dorsum, as a rule, in rows from the median plane forward and lateralward.

2. *Papillae fungiformes,* flask-like projections, of reddish color, larger than the preceding, scattered between them, especially in the anterior half of the tongue; frequently accumulated at the point of the tongue. On the lateral margins of he tongue especially they are often markedly flattened and are then called *papillae lenticulares. Papillae conicae* is the name of papillae fungiformes which, owing to their more pointed shape, resemble the papillae filiformes.

3. *Papillae vallatae* (O. T. circumvallate papillae), the largest of all, 6—16, most often 9, are situated almost parallel to and in front of the sulcus terminalis in the form of a **V** or **Λ**, the most posterior is situated a little in front of the foramen caecum. They are short, cylindrical elevations, which are surrounded by a circular groove and a ridge of mucous membrane and project slightly above their surroundings.

4. *Papillae foliatae,* on each side on the margo lateralis linguae, a little in front of the beginning of the arcus glossopalatinus, are very variable and consist of from 4—8 nearly vertically placed folds separated by grooves and projecting but little above the surroundings.

Folliculi linguales are accumulations of lympathic tissue ith nodules) on the root of the tongue which produce variably large lens-shaped elevations in the mucous membrane. They may be partly fused with one another, extend backward as far as the epiglottis, laterally as far as the palate tonsils and are collectively termed *tonsilla lingualis.* Their average number is 66. Each one has a small, crater-shaped depression (see also Fig. 605).



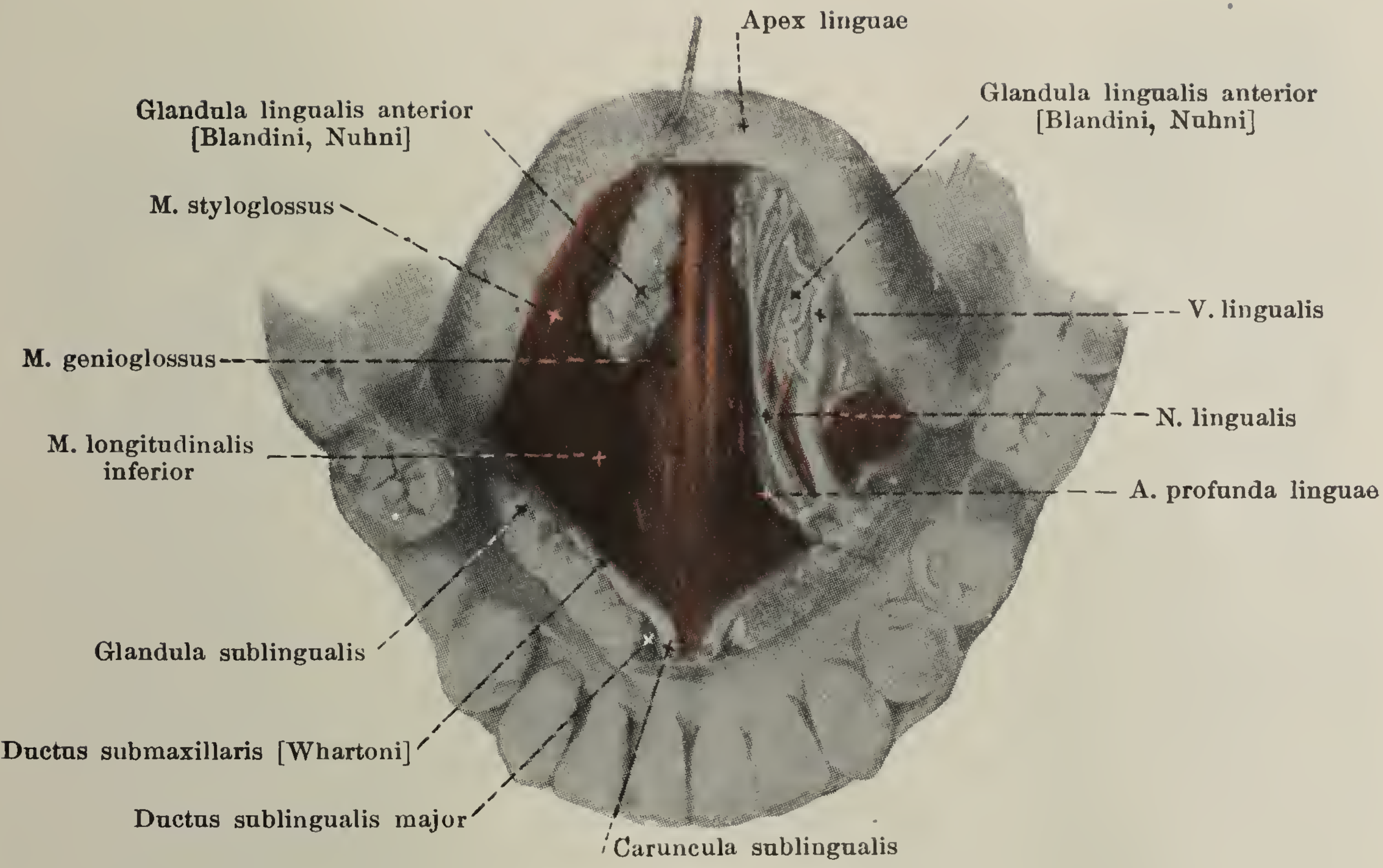
589. Inferior surface of the tongue and its surroundings, the tip of the tongue being elevated.

Mucous membrane of the tongue (continued). Passing out from the root of the tongue (see Fig. 581) in the median plane is a large fold of mucous membrane, *plica glossoepiglottica mediana* (median glosso-epiglottidean fold), and lateralward from it on each side a smaller, *plica glossoepiglottica lateralis;* these folds extend to the anterior surface of the epiglottis. Between them on each side lies a fossa-like depression, *vallecula epiglottica.*

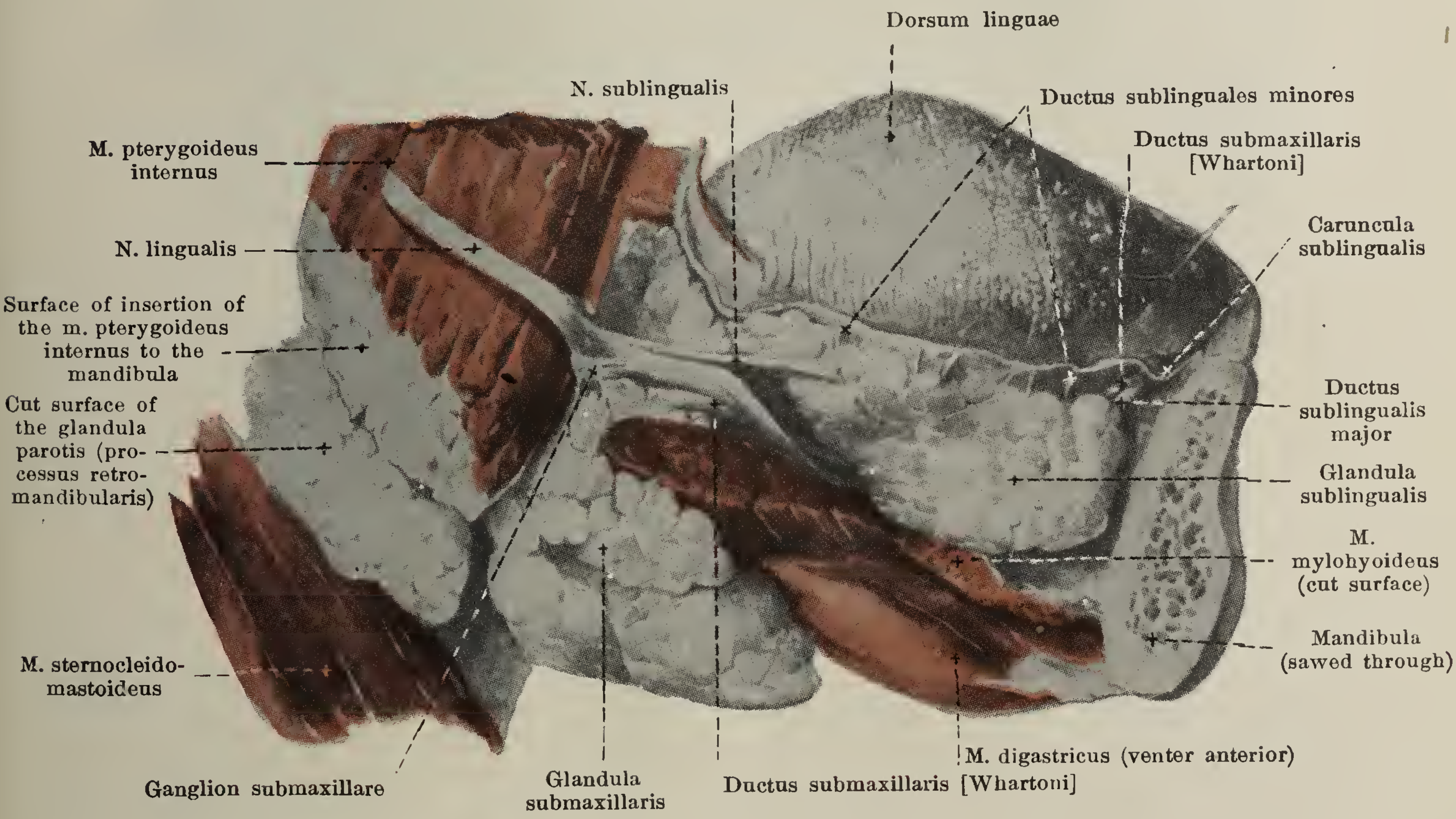
The mucous membrane of the facies inferior linguae is smooth and presents only two symmetrical low, narrow folds, *plicae fimbriatae,* which converge in front; the free margin of each fold is for some distance finely jagged. These folds are more distinct in the new-born and in children than in the adult. In the median plane extending from the inferior surface of the tongue to the gums is a fold of mucous membrane, the *frenulum linguae.* Close to it on each side lies a small round nodule, *caruncula sublingualis,* which contains the opening of the ductus submaxillaris and sometimes also that of the ductus sublingualis major. On the region between the frenulum linguae and the arcus glossopalatinus the mucous membrane goes over in a flat curve upon the gums; at the point where it covers the glandula sublingualis it is elevated to form a long nodular ridge, the *plica sublingualis* (sublingual fold), which runs from the caruncula sublingualis on backward and lateralward; upon this ridge open the ductus sublinguales minores in small wart-like elevations.

The *glandulae linguales posteriores* (see Fig. 584) lie in large numbers just beneath the mucous membrane of the posterior half of the tongue lateralward as far as the palate tonsils.

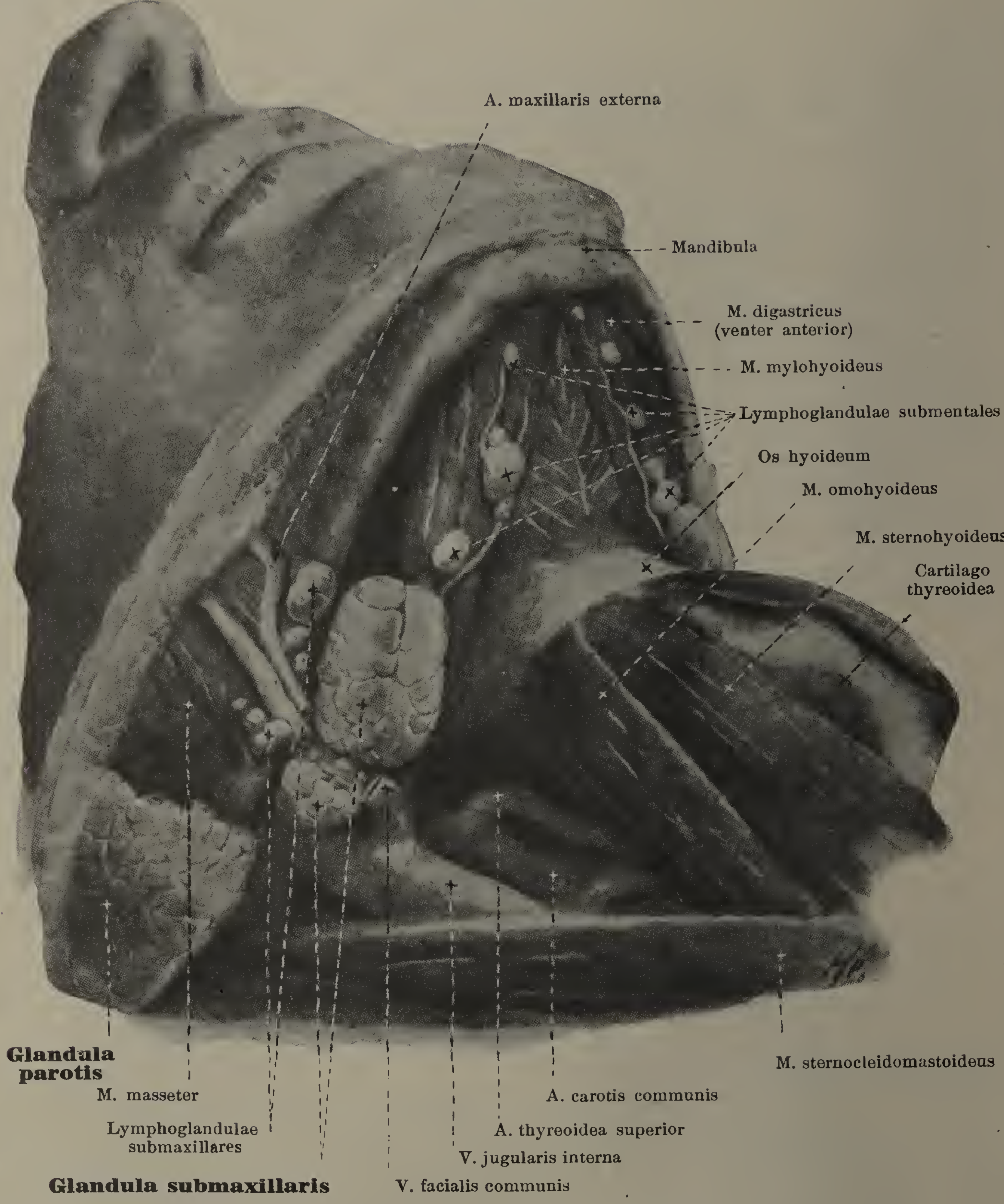
The *glandula lingualis anterior [Blandini, Nuhni]* (O. T. gland of Nuhn) (see Figs. 586 and 590) is an oblong body on each side lying lateralward from the anterior extremity of the m. genioglossus close behind the tip of the tongue; it is covered on its inferior surface by some fibres of the mm. styloglossus and longitudinalis inferior. It becomes thinner in front and combines with the one on the other side in a pointed curve. Its ducts (5—7) open on small protuberances of the mucous membrane medially of the plica fimbriata, sometimes in two rows.


Apex linguae
Glandula lingualis anterior [Blandini, Nuhni]
Glandula lingualis anterior [Blandini, Nuhni]
M. styloglossus
V. lingualis
M. genioglossus
N. lingualis
M. longitudinalis inferior
A. profunda linguae
Glandula sublingualis
Ductus submaxillaris [Whartoni]
Ductus sublingualis major
Caruncula sublingualis

590. Inferior surface of the tongue,
after removal of the mucous membrane, the tip of the tongue being elevated.
(On the right the blood vessels and nerves have been removed, as have also the superficial fibres of the mm. styloglossus and longitudinalis inferior as far as they cover the glandula lingualis anterior.)

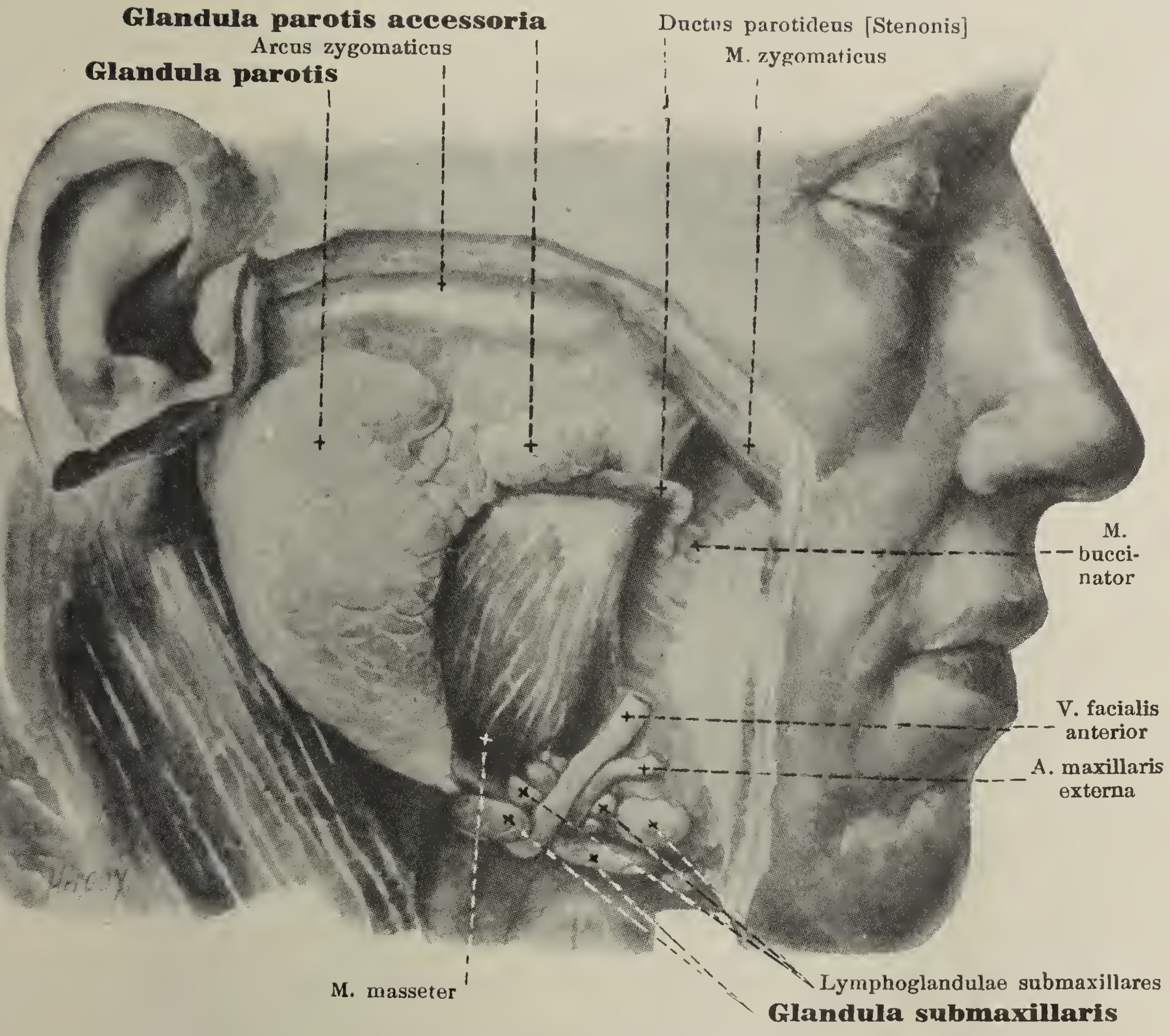

Dorsum linguae
N. sublingualis
Ductus sublinguales minores
M. pterygoideus internus
Ductus submaxillaris [Whartoni]
Caruncula sublingualis
N. lingualis
Surface of insertion of the m. pterygoideus internus to the mandibula
Cut surface of the glandula parotis (processus retromandibularis)
Ductus sublingualis major
Glandula sublingualis
M. mylohyoideus (cut surface)
Mandibula (sawed through)
M. sternocleidomastoideus
M. digastricus (venter anterior)
Ganglion submaxillare
Glandula submaxillaris
Ductus submaxillaris [Whartoni]

591. Salivary glands of the right side,
after removal of the right half of the lower jaw, viewed from the right.
(The glandula parotis has been in large part removed.)



592. Right submaxillary gland and its neighborhood, viewed from the right and below.
(The platysma has been removed.)

The **glandula sublingualis** *(sublingual gland)* (see Figs. 568, 590 and 591) is oblong, narrow, longer from before backward than from above downward. It lies directly upon the m. mylohyoideus between the mm. geniohyoideus, genioglossus and hyoglossus on the one hand and the medial surface of the corpus mandibulae on the other and lies in the fovea sublingualis of the latter; above it is directly covered by the mucous membrane of the mouth and there causes the plica sublingualis to project (see Fig. 589). Behind it is adjacent to the glandula submaxillaris. It is of very varying structure. The main mass of its lobes opens with numerous (5—20 or more) narrow and short ducts, *ductus sublinguales minores*, upon the plica sublingualis; an anterior group of lobes sometimes sends out a larger duct, the *ductus sublingualis major*, which runs forward and upward on the medial surface of the gland beneath the ductus submaxillaris and usually goes into the latter or more seldom opens close to it upon the caruncula sublingualis.

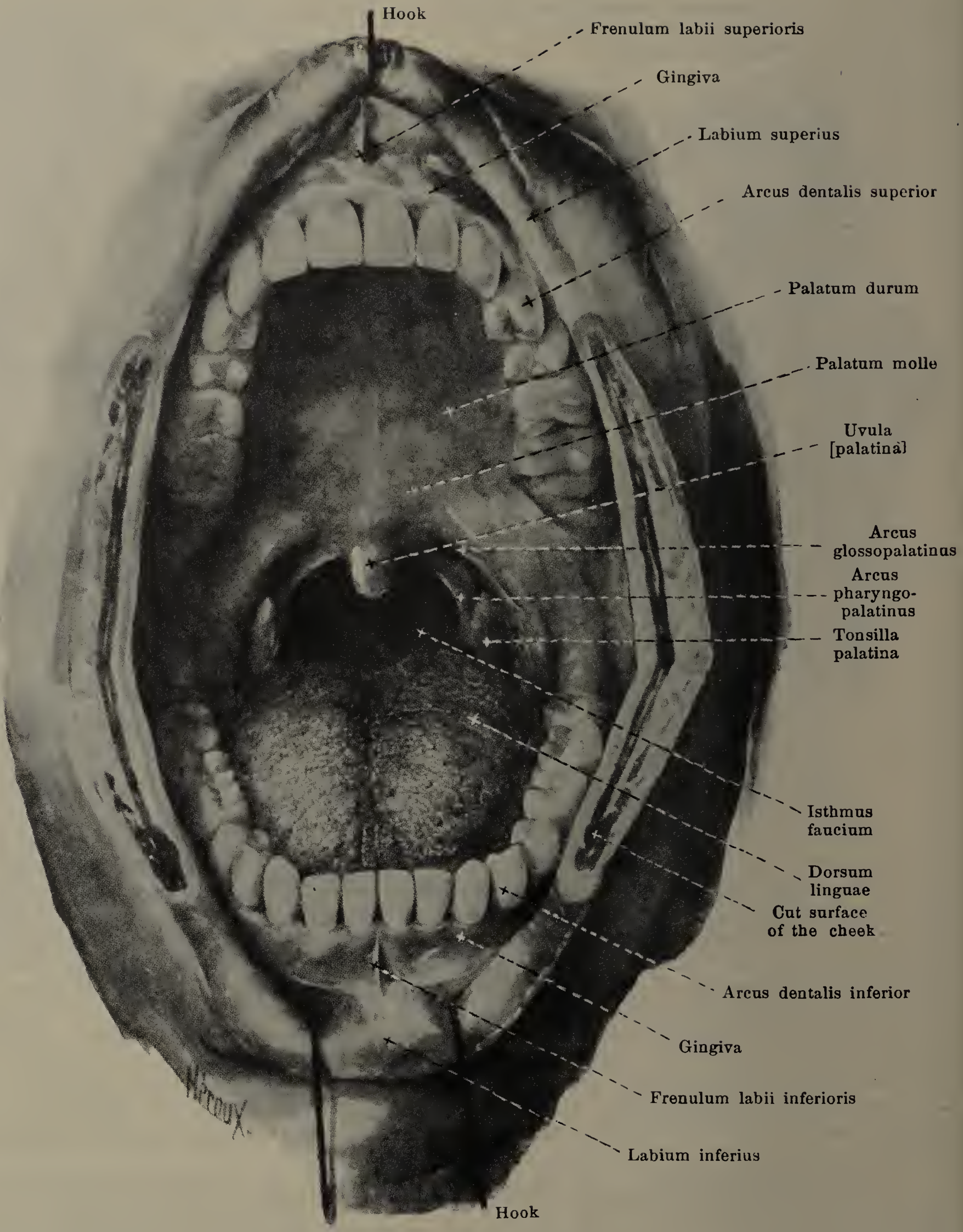


593. Right parotid gland, viewed from the right.

(The platysma and the nerves have been completely removed; the vessels have been partially removed.)

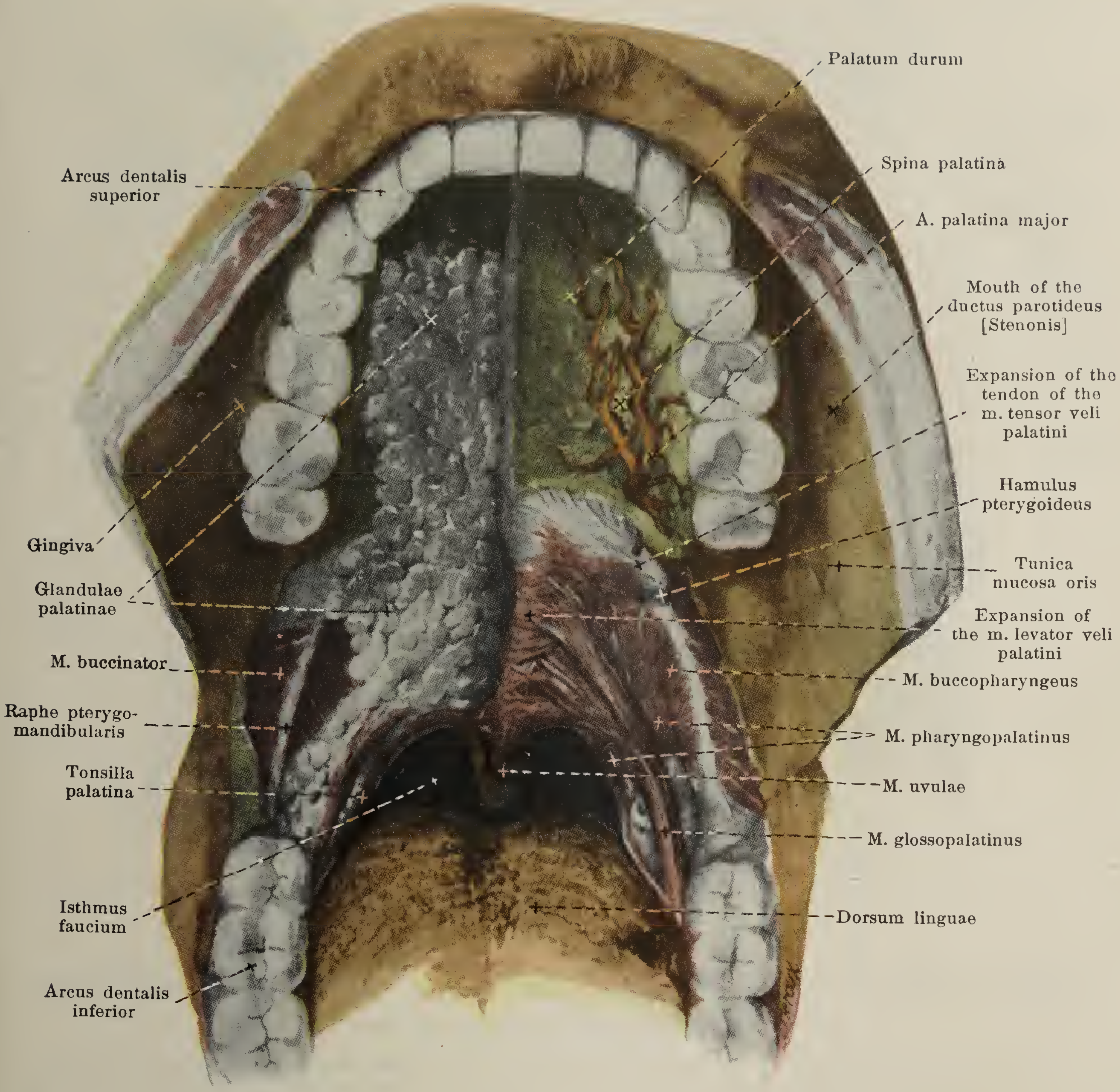
The **glandula submaxillaris** *(submaxillary gland)* (see also Figs. 591 and 592) has the shape of a flattened egg. It lies in the fossa which is bounded above and lateralward by the fovea submaxillaris of the mandibula, elsewhere by the mm. digastricus and stylohyoideus. Above and medially it is in contact with the inferior surface of the m. mylohyoideus and sends (near the ductus submaxillaris) around its posterior margin to its upper surface a process of variable size which reaches the glandula sublingualis or even may accompany it a certain distance of variable length, and comes in contact medianward with the m. hyoglossus. Behind it often reaches as far as the glandula parotis and touches the m. pterygoideus internus. Its free surface is crossed by the v. facialis anterior and covered by the platysma. The excretory duct, *ductus submaxillaris [Whartoni]* (see Figs. 568, 590 and 591), emerges at the posterior margin of the m. mylohyoideus from the inner surfcae of the gland, runs forward and upward on the medial surface of the glandula sublingualis and opens into the caruncula sublingualis.

The **glandula parotis** *(parotid gland)* (see also Fig. 592) is approximately triangular on its lateral slightly convex surface. With its medial, narrowed portion, *processus retromandibularis* (see Fig. 591), it fills up the fossa which is bounded in front by the posterior margin of the ramus mandibulae and the m. pterygoideus internus, behind by the pars tympânica oss. temporalis, by the cartilago meatus acustici as well as by the anterior margin of the proc. mastoideus and of the m. sternocleidomastoideus; in the depth it comes into contact with the proc. styloideus, the mm. stylohyoideus and styloglossus, the a. carotis interna and the v. jugularis interna. Lateralward it passes forward upon the ramus mandibulae and m. masseter and reaches almost as far as the arcus zygomaticus. Below it tapers out and terminates close beneath the angulus mandibulae and often touches the glandula submaxillaris. Inside the gland run for some distance the a. carotis externa and several of its branches, the v. facialis posterior as well as the n. facialis and its peripheral branches. The duct, *ductus parotideus [Stenonis]*, goes off from the upper portion of the anterior margin, runs approximately horizontally forward upon the lateral surface of the m. masseter, then bends medianward, perforates the m. buccinator obliquely and opens in the vestibulum oris opposite the second (or first) upper molar tooth (see Fig. 595); upon the m. masseter there often lies on the duct a *glandula parotis accessoria* which is of variable size.



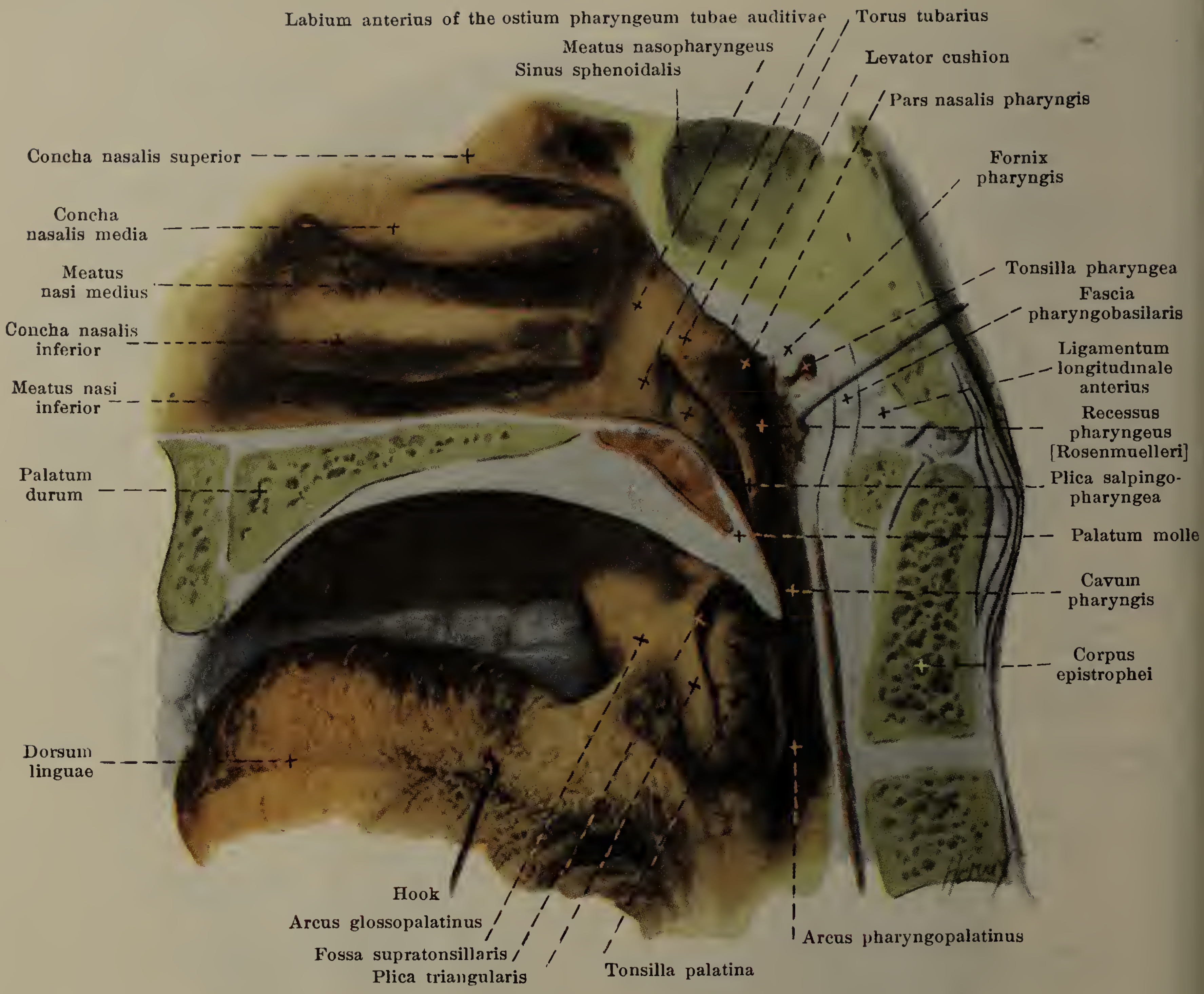
594. The mouth cavity, viewed from in front, after deep incisions in the cheeks (starting from the angles of the mouth) forced wide open.

The roof of the mouth cavity is formed by the **palate** *(palatum)* (see also Figs. 567, 568, 579, 595 and 596), which is curved so as to be more concave from the right to the left than from before backward. The substratum of the palate is bony in front *(palatum durum)* and consists there of the processus alveolares and palatini of the upper-jaw-bones and the partes horizontales of the palate bones (see also Figs. 61 and 62); in the posterior part it is muscular *(palatum molle).* The mucous membrane, very firmly attached to the substratum especially in the hard palate, is in general smooth and goes directly over forward and lateralward into the gums, behind into the uvula and the palatal arches.



595. The palate, after removal of the mucosa, viewed from below.
(On the left side the palatal glands have also been removed; the cheeks have been drawn away from the teeth.)

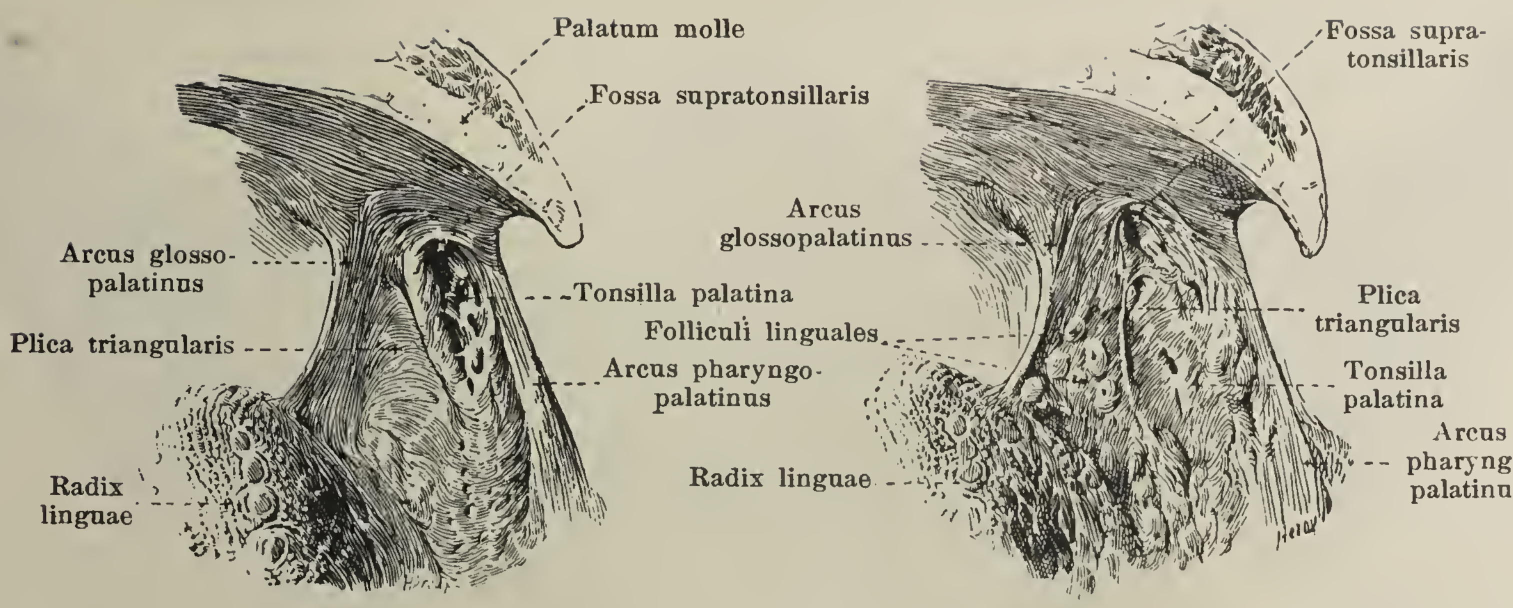
The **mucous membrane of the palate** (see Fig. 579) presents in the median plane a narrow, whitish streack, the *raphe palati,* which in front is often ridge-like in shape, but behind has usually the form of a groove. Running out from it just behind the incisor teeth on each side can be seen one or several low ridges, *plicae palatinae transversae,* straight or curved lateralward. In front of them in the median plane is a small projection, the *papilla incisiva,* which extends partly between the two medial incisor teeth. At the junction of the hard and soft palate there is very frequently visible on each side of the raphe a small depression, *foveola palatina,* into which merge the openings of the excretory ducts of several glands. The mucous membrane is thinnest in the region of the raphe, especially on the hard palate. Lateralward a thick layer of *palatal glands, glandulae palatinae* (see also Fig. 568), fills up on each side the deep groove between the hard palate and the processus alveolaris maxillae. This layer of glands becomes narrower medianward and in front, is especially thick in the anterior part of the soft palate and decreases in thickness again also farther back; the glands are here partly imbedded in the muscles. Larger glands are to be found also on the anterior, smaller glands on the posterior surface of the uvula (see Fig. 567).



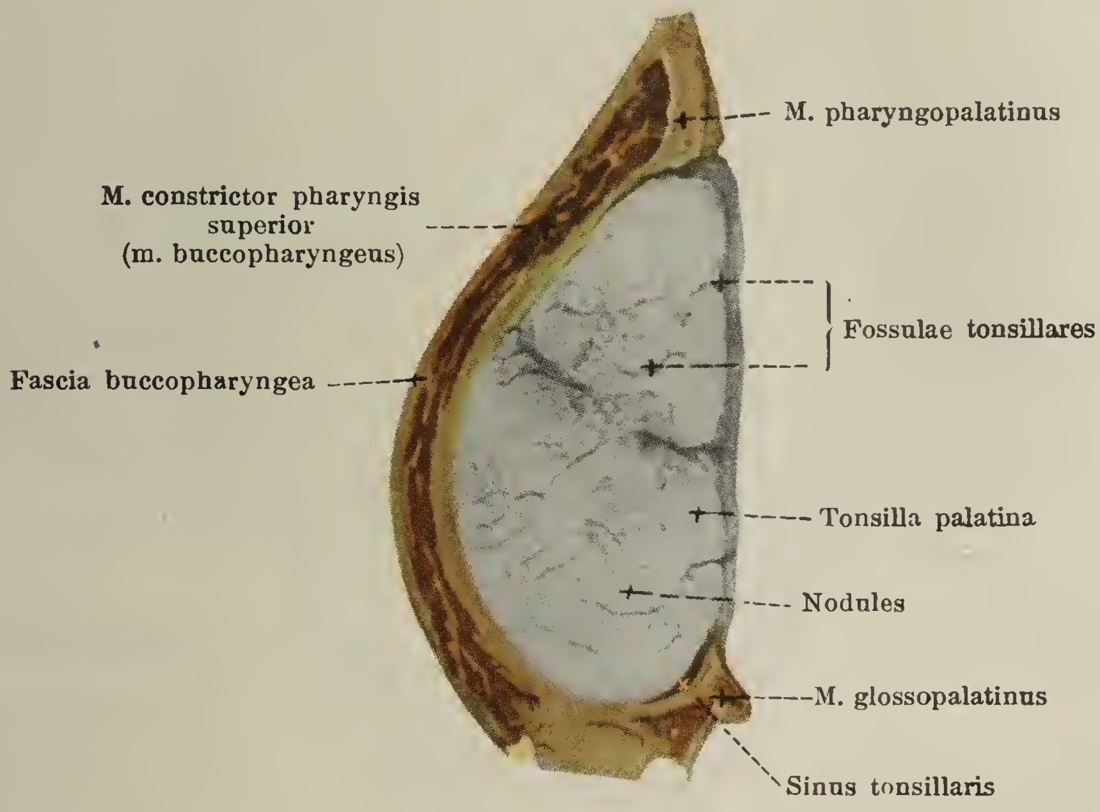
596. Right half of the pharynx and its neighborhood, viewed from the left.

(The head has been halved in the median plane; the tongue has been drawn downward.)

The **soft palate** *(palatum molle)* (see also Figs. 567, 594 and 600) is a thick transversely placed membrane, which contains within it the expansion of several muscles (see p. 524). The anterior portion connected with the hard palate is placed nearly horizontally; the posterior portion, *velum palatinum (palatal sail)*, is directed obliquely backward and downward, terminating (see also Fig. 579) behind and lateralward on each side in a free margin, the *arcus pharyngopalatinus;* in the middle it is drawn out to form the small, conical, very variable, *uvula [palatina]*. The mucous membrane which covers the inferior surface of the soft palate is directly continued at its free margin upon the upper surface into the mucous membrane of the pharynx and of the nasal cavity. The *arcus pharyngopalatinus (posterior palatal arch)* (see also Fig. 600) is thicker above, thinner below where it has almost a sharp edge; from the lateral margin of the uvula it bends so as to be markedly concave downward and a little backward and becomes lost in the lateral wall of the pars laryngea pharyngis. Arising from the lower surface of the velum palatinum on each side a little in front of the base of the uvula (see also Figs. 579 and 594) is a fold of mucous membrane, the *arcus glossopalatinus (anterior palatal arch)*, which, curved so as to be slightly concave, extends downward and lateralward and unites behind the papillae foliatae with the lateral margin of the tongue (see also Fig. 581). From the posterior surface of this anterior palatal arch a thin, very variable triangular fold of mucous membrane, the *plica triangularis*, passes dorsalward; it is narrow at its beginning above but is broad at its attachment to the lateral margin of the tongue. Lateralward from and dorsal to it, reaching behind as far as the arcus pharyngopalatinus, lies, in the embryo, a deep fossa, the *sinus tonsillaris*, from the bottom of which the tonsilla palatina develops.



597 and 598. Right palatine tonsils, unequally developed, viewed from the left (see Fig. 596).

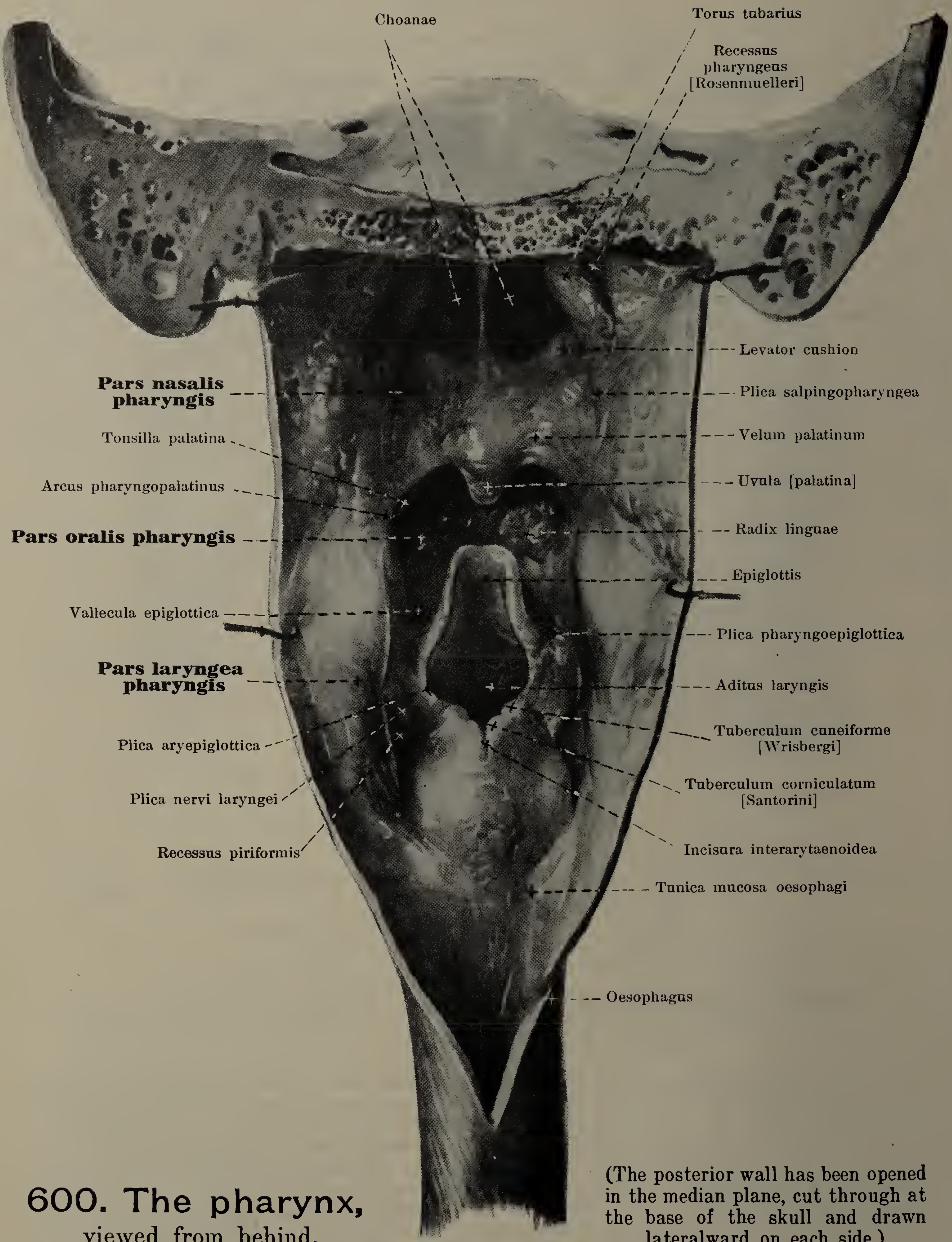


599. Right palatine tonsil, cut through horizontally.

Magnification: 2 : 1.

The *tonsilla palatina (palatine tonsil)* (see also Figs. 594—596) is a very variable oblong body usually shaped like a flattened egg, of the size of an almond or somewhat larger, which lies on each side between the two palatal arches; it is bounded lateralward by the m. buccopharyngeus and looks, with its medial nodular surface, more or less deeply free into the mouth cavity. From this surface 10—20 smaller or larger oblong openings lead into single or forked slits, the *fossulae tonsillares*, which penetrate very deep into the tonsils and are surrounded by a thick layer of lympathic tissue containing nodules. The tonsil is very frequently confined only to the embryonal sinus tonsillaris (see p. 518); but in other cases the tonsil-tissue penetrates the plica triangularis also, so that the latter may vanish more or less entirely. Folliculi linguales may extend as far as the free margin of the plica triangularis or its remainder (see Figs. 596 and 598). In front of the superior pole of the tonsil runs always laterally from the plica triangularis as a remainder of the embryonal sinus tonsillaris a slit-shaped groove, *fossa supratonsillaris* (see Figs. 596—598), to a variable distance upward and forward.

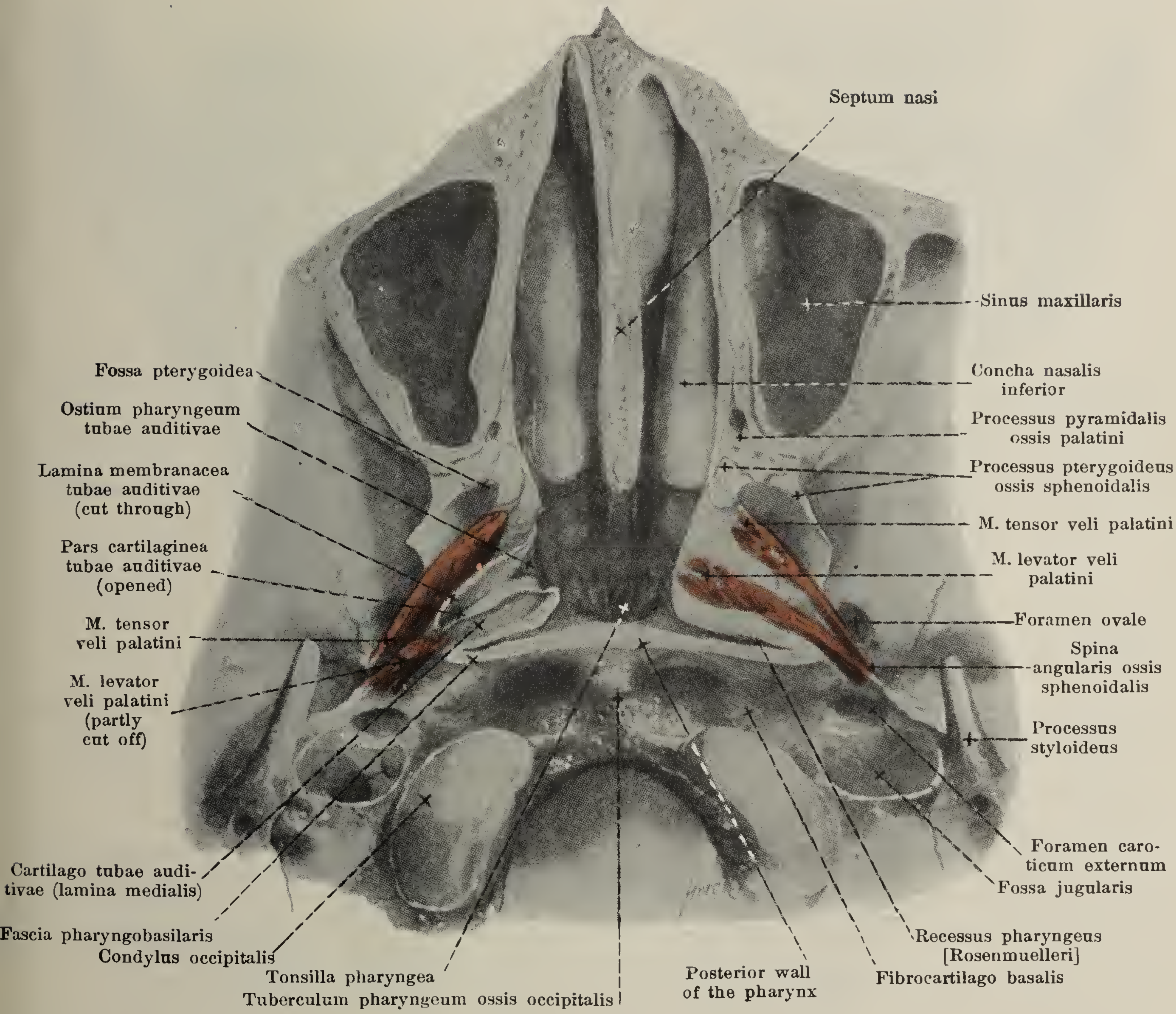
The space enclosed by the soft palate, the palatal arches and the root of the tongue is called the *isthmus faucium* (see Fig. 594).



600. The pharynx, viewed from behind.

(The posterior wall has been opened in the median plane, cut through at the base of the skull and drawn lateralward on each side.)

The **pharynx** (see also Figs. 567 and 596) is an unpaired, tube-like cavity which is situated behind the nose, mouth and larynx; it is correspondingly divided into three portions, which, however, are not sharply separable from one another: ***pars nasalis***, ***pars oralis*** and ***pars laryngea.*** The cavity surrounded by its walls, ***cavum pharyngis***, is connected in front with the three cavities mentioned. Its frontal diameter is everywhere greater than the sagittal but diminishes markedly and suddenly at the inferior end.

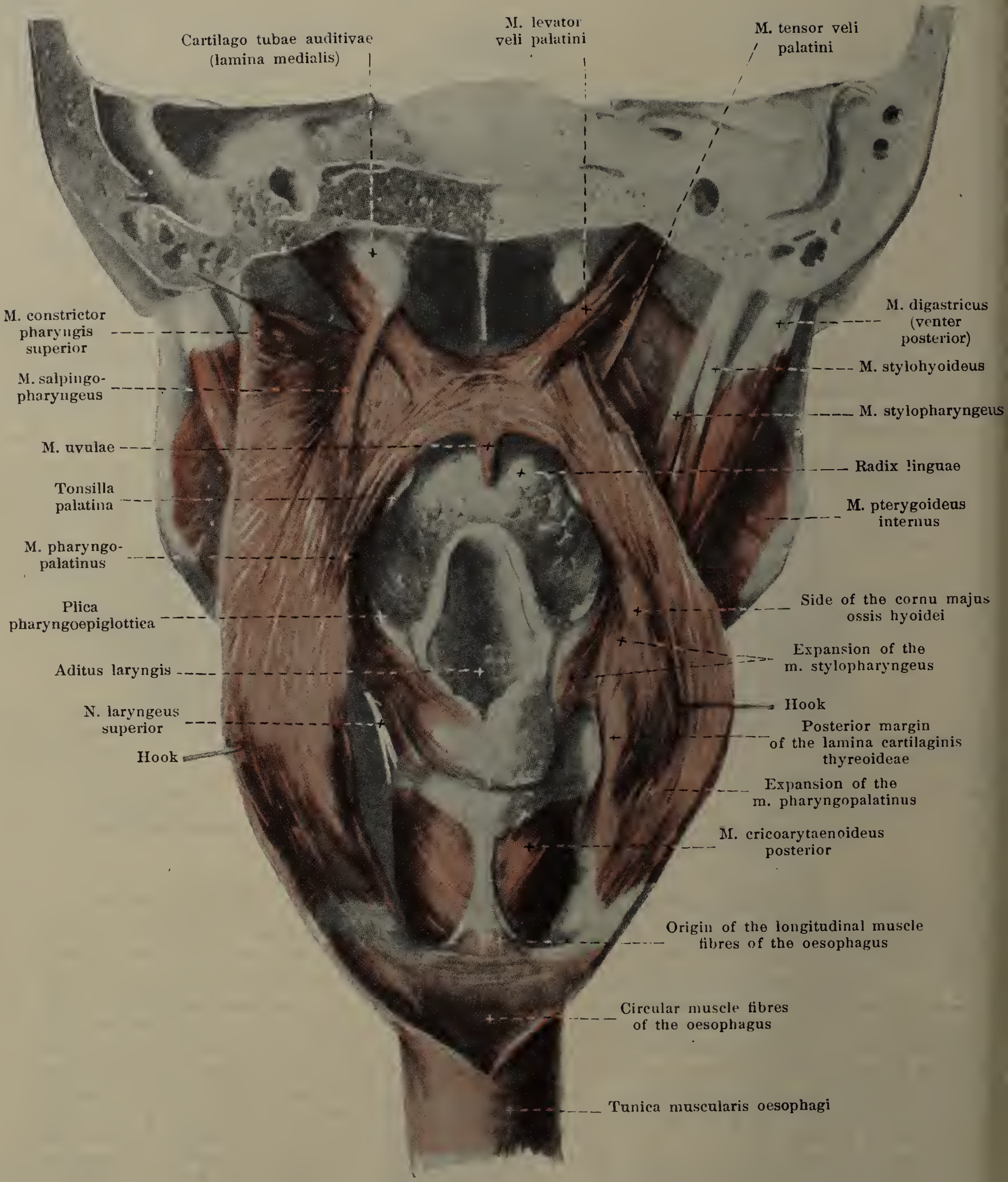

Septum nasi
Sinus maxillaris
Fossa pterygoidea
Concha nasalis inferior
Ostium pharyngeum tubae auditivae
Processus pyramidalis ossis palatini
Lamina membranacea tubae auditivae (cut through)
Processus pterygoideus ossis sphenoidalis
M. tensor veli palatini
Pars cartilaginea tubae auditivae (opened)
M. levator veli palatini
M. tensor veli palatini
Foramen ovale
Spina angularis ossis sphenoidalis
M. levator veli palatini (partly cut off)
Processus styloideus
Cartilago tubae auditivae (lamina medialis)
Foramen caroticum externum
Fossa jugularis
Fascia pharyngobasilaris
Condylus occipitalis
Recessus pharyngeus [Rosenmuelleri]
Tonsilla pharyngea
Posterior wall of the pharynx
Fibrocartilago basalis
Tuberculum pharyngeum ossis occipitalis

601. Upper end of the pharynx, viewed from below.

(Horizontal section at the level of the nasal surface of the hard palate; in the right half the m. levator veli palatini has been partially removed, the pars cartilaginea tubae has been opened.)

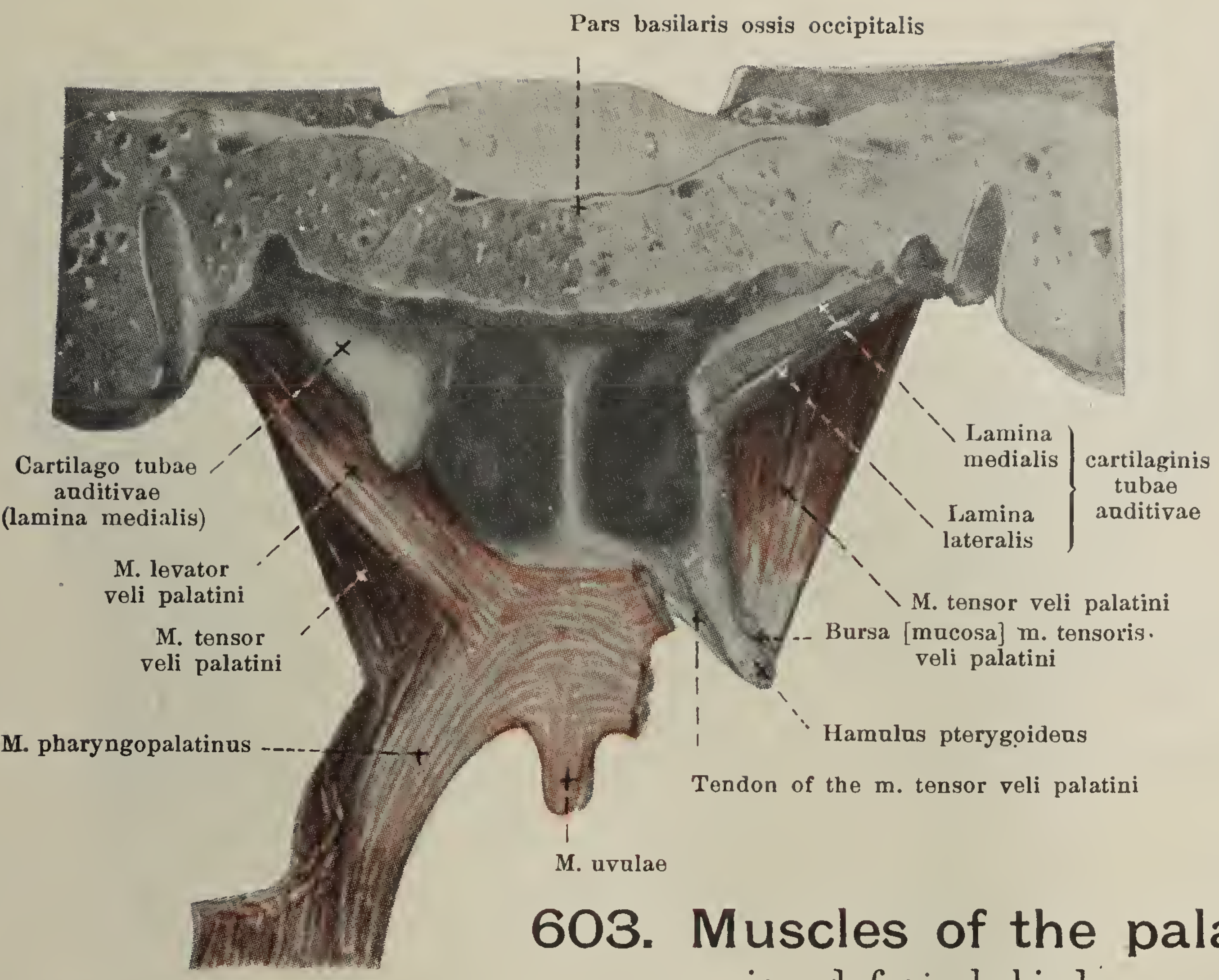
The upper end of the pharynx, *fornix pharyngis*, is bounded chiefly by the inferior surface of the body of the sphenoid bone and of the pars basilaris oss. occipitalis; the line of attachment goes on each side lateralward from the tuberculum pharyngeum oss. occipitalis beneath the fibrocartilago basalis (see also Fig. 953) and the apex of the pyramid of the temporal bone as far as in front of the foramen caroticum externum, turns again medianward behind the cartilage of the tuba auditiva and then extends to the medial surface of the lamina medialis of the processus pterygoideus. Its posterior wall lies directly in front of the bodies of the upper 6 cervical vertebrae and in front of the mm. recti capitis anteriores, longi capitis and colli, separated from them only by the fascia praevertebralis. Lateralward it is bounded by the aa. carotides communes et internae, the vv. jugulares internae, the cornua majora of the hyoid bone and the laminae cartilaginis thyreoidae. Below at the 6th cervical vertebra it goes over into the oesophagus.

The **wall of the pharynx** consists of the *tunica mucosa (mucous membrane)*, *tela submucosa* and *tunica muscularis pharyngis.* The mucous membrane (see Fig. 600) completely covers the internal surface and is uninterruptedly continuous with that of the neighboring cavities. At the fornix pharyngis and in the uppermost part of the posterior wall, it is thickened by the presence of lymphatic tissue with nodules in a varying manner and subdivided by slits *(fossulae tonsillares).* This place is called the *tonsilla pharyngea, pharyngeal tonsil* (see also Fig. 596), and is much more highly developed in children than in adults. On its inferior boundary there is sometimes found in children in the median plane a small blind-sack-like depression, *bursa pharyngea* (not illustrated), extending as far as the os occipitale.


Cartilago tubae auditivae (lamina medialis)
M. levator veli palatini
M. tensor veli palatini
M. constrictor pharyngis superior
M. salpingo-pharyngeus
M. uvulae
Tonsilla palatina
M. pharyngo-palatinus
Plica pharyngoepiglottica
Aditus laryngis
N. laryngeus superior
Hook
M. digastricus (venter posterior)
M. stylohyoideus
M. stylopharyngeus
Radix linguae
M. pterygoideus internus
Side of the cornu majus ossis hyoidei
Expansion of the m. stylopharyngeus
Hook
Posterior margin of the lamina cartilaginis thyreoideae
Expansion of the m. pharyngopalatinus
M. cricoarytaenoideus posterior
Origin of the longitudinal muscle fibres of the oesophagus
Circular muscle fibres of the oesophagus
Tunica muscularis oesophagi

602. Muscles of the palate and pharynx,
viewed from behind.

(The pharynx has been opened as in Fig. 600; the tunica mucosa and tela submucosa have been dissected away, except for a small area of the pars laryngea. On the right side the m. salpingo-pharyngeus, a part of the m. constrictor pharyngis superior and a corner of the cartilago tubae auditivae have been removed.)


Pars basilaris ossis occipitalis
Cartilago tubae auditivae (lamina medialis)
M. levator veli palatini
M. tensor veli palatini
M. pharyngopalatinus
Lamina medialis
Lamina lateralis
cartilaginis tubae auditivae
M. tensor veli palatini
Bursa [mucosa] m. tensoris veli palatini
Hamulus pterygoideus
Tendon of the m. tensor veli palatini
M. uvulae

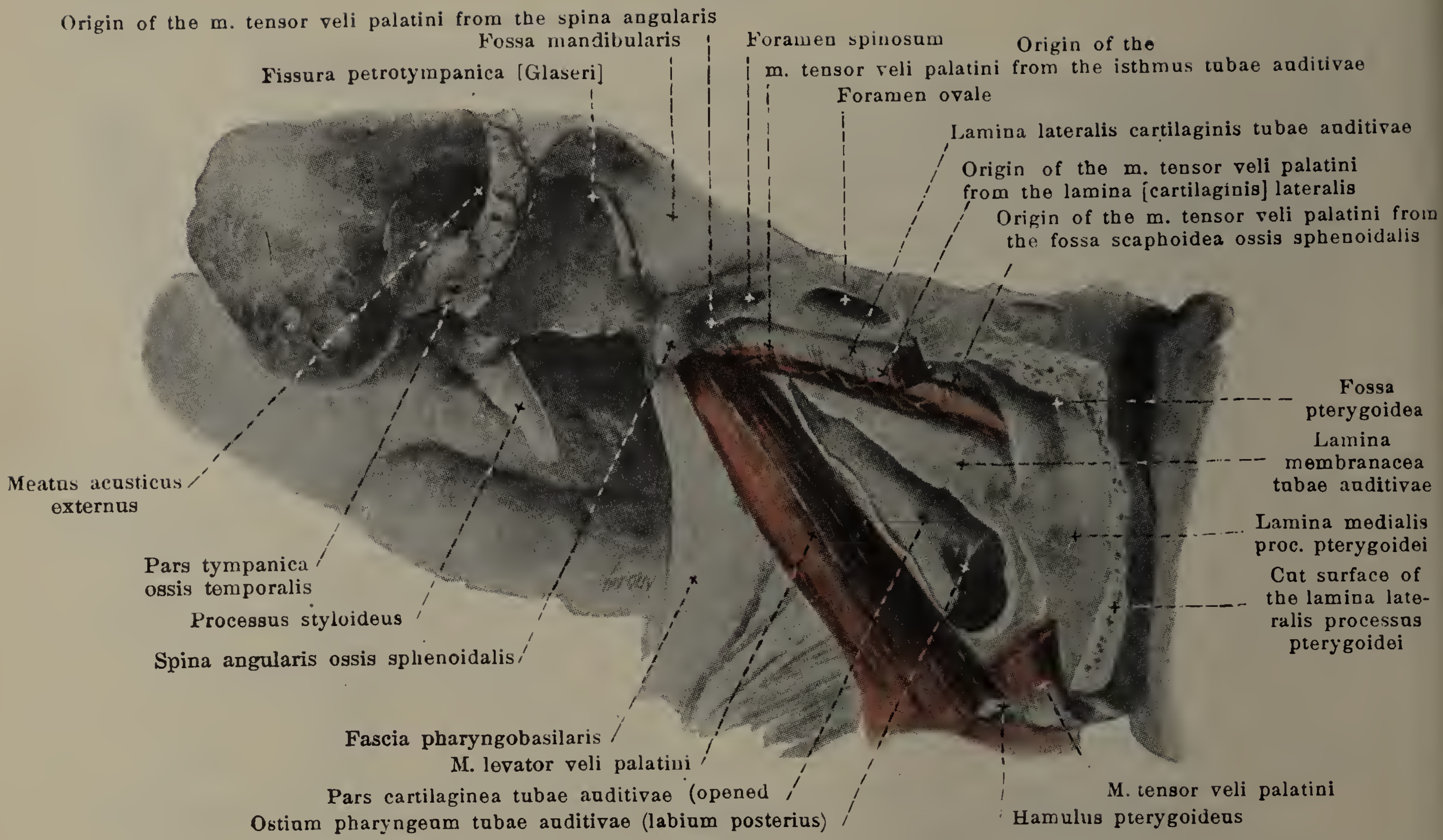
603. Muscles of the palate, viewed from behind.

(On the right side the m. levator veli palatini and the m. pharyngopalatinus have been removed. In addition the lamina medialis of the cartilago tubae auditivae has been partially cut away and the pars cartilaginea of the Eustachian tube has been opened for a corresponding length.)

In the pars nasalis pharyngis (see Figs. 596, 600, 601, 982 and 983) on each side lateralward, behind the insertion of the inferior turbinated bone, is visible the sickle-shaped *ostium pharyngeum tubae auditive;* it is surrounded above and behind by a horse-shoe-shaped ridge. The anterior part of the ridge, *labium anterius,* is the smaller; the upper and posterior part *(labium posterius)* is thicker and harder, being made prominent by the lamina medialis of the cartilago tubae auditivae (see p. 842) whence it is also called the *torus tubarius.* The opening is encroached upon from below by a projection caused by the m. levator veli palatini *(levator cushion).* From the lower end of the labium posterius a fold of mucous membrane, *plica salpingopharyngea,* extends downward for a variabl distance on the lateral wall. Behind the torus tubarius, extending far lateralward, is a pocket, usually slit-shaped, the *recessus pharyngeus [Rosenmuelleri]* (pharyngeal recess of Rosenmueller). The partition between the pars nasalis and the pars oralis, formed by the velum palatinum, is indistinct and incomplete. Lateralward in the pars oralis is the arcus pharyngopalatinus; the pars oralis (see Figs. 567, 596 and 600) is not sharply marked off from the pars laryngea. In the pars laryngea (see Fig. 600), extending lateralward from the lateral margin of the epiglottis, is the low *plica pharyngoepiglottica.* Below and behind it on each side between the plica aryepiglottica and the lamina cartilaginis thyreoideae, which is covered directly by the mucous membrane, lies a deep fossa, the *recessus piriformis* (O. T. sinus pyriformis) which runs downward in the form of a groove; a fold, *plica nervi laryngei* (caused by the r. internus n. laryngei superioris), runs obliquely downward and medianward in its most anterior part. *Glandulae pharyngae* (not illustrated) are to be found in the tunica mucosa of the fornix, particularly behind the tonsilla pharyngea, also in the tela submucosa of the remaining part of the region, especially in the recessus pharyngeus and in the plica salpingopharyngea.

Muscles of the palate *(musculi palati et faucium)* (see also Figs. 595, 602 and 605).

M. pharyngopalatinus (O. T. palatopharyngeus). Form: triangular, thin, long. Position: for the most part in the arcus pharyngopalatinus. Origin: broad in the tela submucosa of the posterior wall of the pars laryngea pharyngis and from the posterior margin of the lamina cartilaginis thyreoideae, in front of the m. constrictor pharyngis inferior. Insertion: the fibres, converging, run in front of the m. constrictor pharyngis medius upward, first lateralward, then medianward, and radiate out transversely into the palate; some fibres go to the hamulus pterygoideus, others as the *m. salpingopharyngeus* (see Fig. 602) in the plica salpingopharyngea to the lower end of the lamina medialis cartilaginis tubae auditivae. Action: both approximate the pharyngopalatine arches, and elevate the inferior part of the pharynx and the larynx. Innervation: rami pharyngei n. vagi.


Origin of the m. tensor veli palatini from the spina angularis
Fossa mandibularis
Fissura petrotympanica [Glaseri]
Foramen spinosum
Origin of the m. tensor veli palatini from the isthmus tubae auditivae
Foramen ovale
Lamina lateralis cartilaginis tubae auditivae
Origin of the m. tensor veli palatini from the lamina [cartilaginis] lateralis
Origin of the m. tensor veli palatini from the fossa scaphoidea ossis sphenoidalis
Fossa pterygoidea
Lamina membranacea tubae auditivae
Lamina medialis proc. pterygoidei
Cut surface of the lamina lateralis processus pterygoidei
Meatus acusticus externus
Pars tympanica ossis temporalis
Processus styloideus
Spina angularis ossis sphenoidalis
Fascia pharyngobasilaris
M. levator veli palatini
Pars cartilaginea tubae auditivae (opened
Ostium pharyngeum tubae auditivae (labium posterius)
M. tensor veli palatini
Hamulus pterygoideus

604. Cartilaginous part of the right Eustachian tube, viewed from the lateral surface and somewhat below and behind.

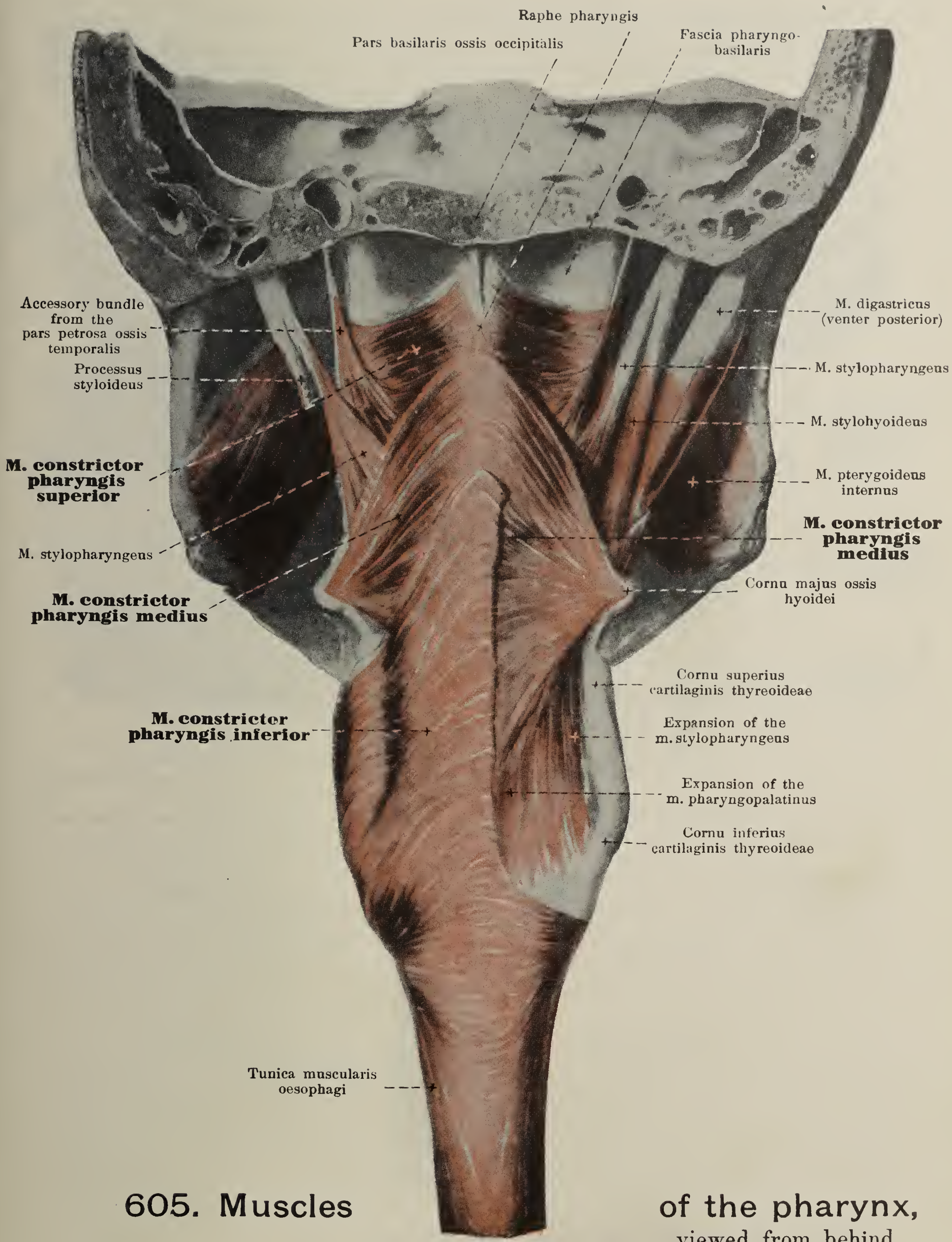
(The lamina lateralis processus pterygoidei, the m. tensor veli palatini and the lamina membranacea of the tuba have been partially, the m. pterygopharyngeus has been completely removed.)

M. glossopalatinus (O. T. palatoglossus) (see Figs. 583 and 595). Form: narrow, long. Position: in the arcus glossopalatinus. Origin: at the lateral margin of the tongue from fibres of the latter which run transversely. Insertion: curving upward it radiates out transversely in the soft palate. Action: the muscle of the two sides together narrow the isthmus faucium. Innervation: rami pharyngei n. vagi.

M. uvulae (O. T. azygos uvulae) (see Figs. 595, 602 and 603). Form: narrow, oblong; frequently paired. Position: in uvula, nearer the upper surface, partly behind other muscles. Origin: tendinous expansions of mm. tensores veli palatini. Insertion: backward and downward to the tip of the uvula. Action: shortens the uvula and draws it backward and upward. Innervation: rami pharyngei n. vagi.

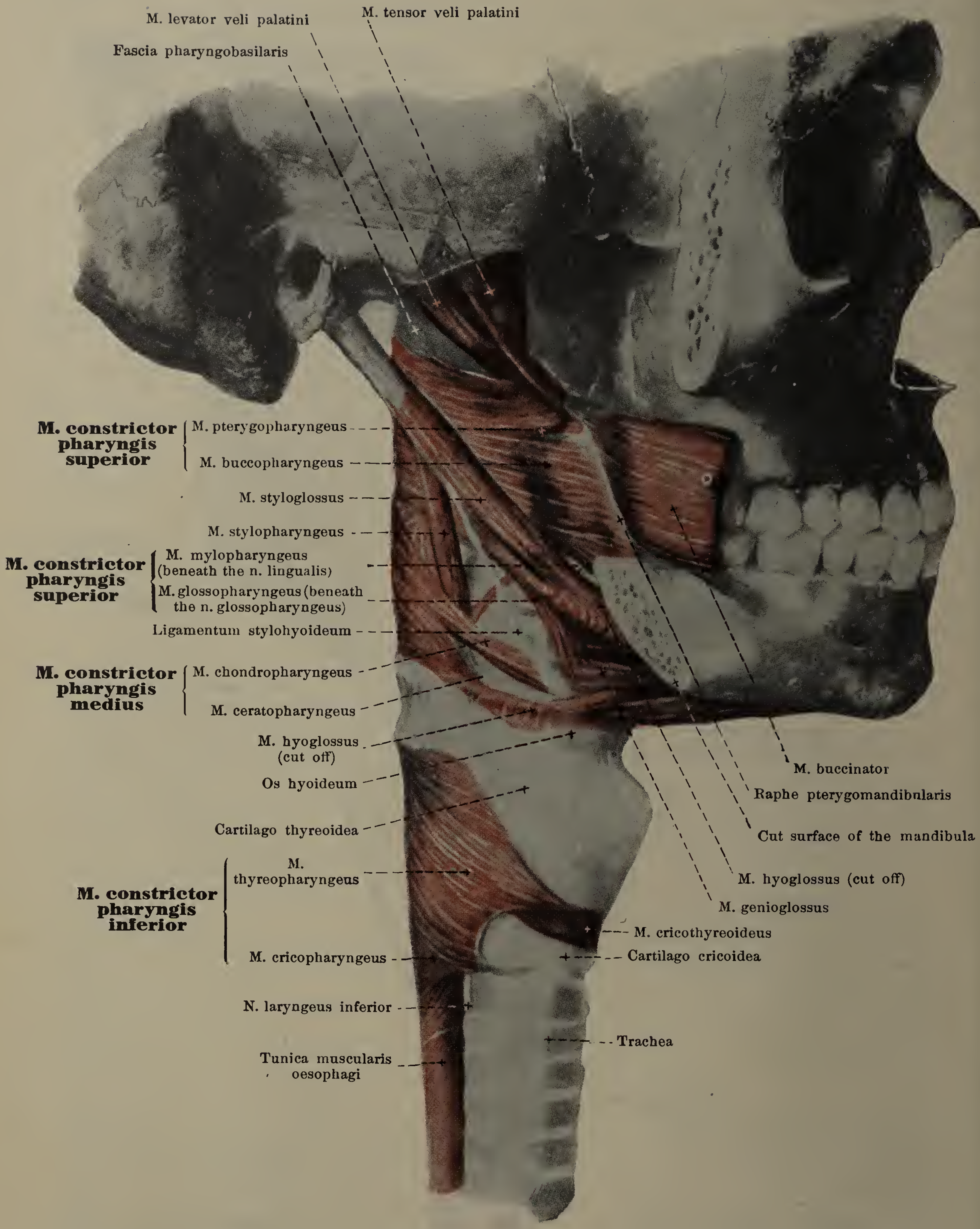
M. levator veli palatini (O. T. levator palati) (see also Figs. 595, 601—603, 606, 954—957). Form: flat-cylindrical. Position: in the uppermost part of the lateral wall of the pharynx, directly in front of the recessus pharyngeus. Origin: facies inferior pyramidis ossis temporalis, just in front of the foramen caroticum externum; some fibres from the lateral end of the lamina medialis of the cartilago tubae and from the adjoining part of the lamina membranacea tubae. Insertion: the fibres are parallel to the inferior margin of the lamina medialis of the cartilago tubae, run downward, medianward and forward (see p. 523) and go to the soft palate. They are there interwoven with the other muscles and unite mainly with the same muscle of the other side. Action: it lifts the velum paaltinum, narrows the ostium pharyngeum and widens the isthmus tubae. Innervation: rami pharyngei n. vagi.

M. tensor veli palatini (see also Figs. 595, 601—603, 606, 954—957). Form: triangular, flat, thin. Position: lateral from the lamina membranacea tubae auditivae and the m. levator veli palatini, medial from the m. pterygoideus internus. Origin: fossa scaphoidea ossis sphenoidalis, lamina [cartilaginis] lateralis and (at the isthmus) lamina membranacea tubae auditivae, spina angularis ossis sphenoidalis. Insertion: the fibres converge and run downward and forward to a small tendon which forms a loop around the sulcus hamuli pterygoidei (here is situated the *bursa m. tensoris veli palatini,* see Fig. 603) and radiates out medianward into the soft palate; there (see Fig. 595) it becomes attached partly to the posterior margin of the pars horizontalis ossis palatini, and becomes connected partly with the fibres of the muscle of the other side. Action: it makes the anterior portion of the soft palate tense and opens the tuba auditiva. Innervation: n. tensoris veli palatini (from the n. mandibularis).


Raphe pharyngis
Pars basilaris ossis occipitalis
Fascia pharyngo-basilaris
Accessory bundle from the pars petrosa ossis temporalis
Processus styloideus
M. constrictor pharyngis superior
M. stylopharyngeus
M. constrictor pharyngis medius
M. constrictor pharyngis inferior
Tunica muscularis oesophagi
M. digastricus (venter posterior)
M. stylopharyngeus
M. stylohyoideus
M. pterygoideus internus
M. constrictor pharyngis medius
Cornu majus ossis hyoidei
Cornu superius cartilaginis thyreoideae
Expansion of the m. stylopharyngeus
Expansion of the m. pharyngopalatinus
Cornu inferius cartilaginis thyreoideae

605. Muscles of the pharynx, viewed from behind.

(On the right side most of the m. constrictor pharyngis inferior has been removed, on the left side the mm. digastricus and stylohyoideus have been removed.)



606. Muscles of the pharynx, viewed from the right.

(The arcus zygomaticus and ramus mandibulae have been completely, the m. hyoglossus has been partially removed.)

The **tunica muscularis pharyngis** (see p.523) consists mainly of the three *mm. constrictores pharyngis (constrictors of the pharynx)*, which surround the posterior and lateral walls, and of which the lower one in each case partly covers the next upper from behind; in addition, this muscular tunic contains the terminal expansions of the *mm. pharyngopalatinus* (see p. 523) and *stylopharyngeus*. The constrictors of the pharynx of the two sides partly fuse behind in the median plane, in part, however, they are connected with a band of connective tissue, the *raphe pharyngis* (see Fig. 605); this raphe is usually distinct in the uppermost part only and is attached to the tuberculum pharyngeum oss. occipitalis. The uppermost constrictor of the pharynx does not reach as far as the base of the skull but leaves an area of variable size free on each side on the posterior and lateral walls in which the tela submucosa pharyngis is visible; this is thicker here and is called the *fascia pharyngobasilaris* (see Figs. 605 and 606).

M. constrictor pharyngis superior (see Figs. 602, 605 and 606) arises from several parts of the head. It is divided into:

1. *M. pterygopharyngeus.* Origin: posterior margin of the lamina medialis of the processus pterygoideus and hamulus pterygoideus.
2. *M. buccopharyngeus.* Origin: raphe pterygomandibularis (see p. 265), partly connected with fibres of the m. buccinator.
3. *M. mylopharyngeus.* Origin: posterior end of the linea mylohyoidea mandibulae in the region of the third molar tooth.
4. *M. glossopharyngeus* (see also Fig. 583). Origin: from fibres running transversely in the root of the tongue, which appear between the posterior bundles of the m. genioglossus, and, covered by the m. hyoglossus, extend obliquely upward.

The fibres run for the most part horizontally backward; the upper ones extend chiefly somewhat upward (see Fig. 605) and becoming tendinous may reach the base of the skull; the lower ones curve behind somewhat downward. The muscle is partly covered behind by the m. constrictor pharyngis medius. Accessory bundles (see Fig. 605) frequently arise at the anterior margin of the foramen caroticum externum, descend behind the muscle at the junction of the lateral and posterior wall and finally turn around into the horizontal direction.

M. constrictor pharyngis medius (see Figs. 582, 583, 605 and 606) arises from the hyoid bone in two parts as the

1. *M. chondropharyngeus.* Origin: cornu minus ossis hyoidei.
2. *M. ceratopharyngeus.* Origin: cornu majus ossis hyoidei.

The fibres arising most anteriorly are covered by the m. hyoglossus; behind the middle fibres run horizontally, the others diverge upward and downward and may, above, even reach the base of the skull. The muscle is covered in its lower larger part by the m. constrictor pharyngis inferior.

M. constrictor pharyngis inferior (see Figs. 605 and 606) arises from the larynx. It is divisible into:

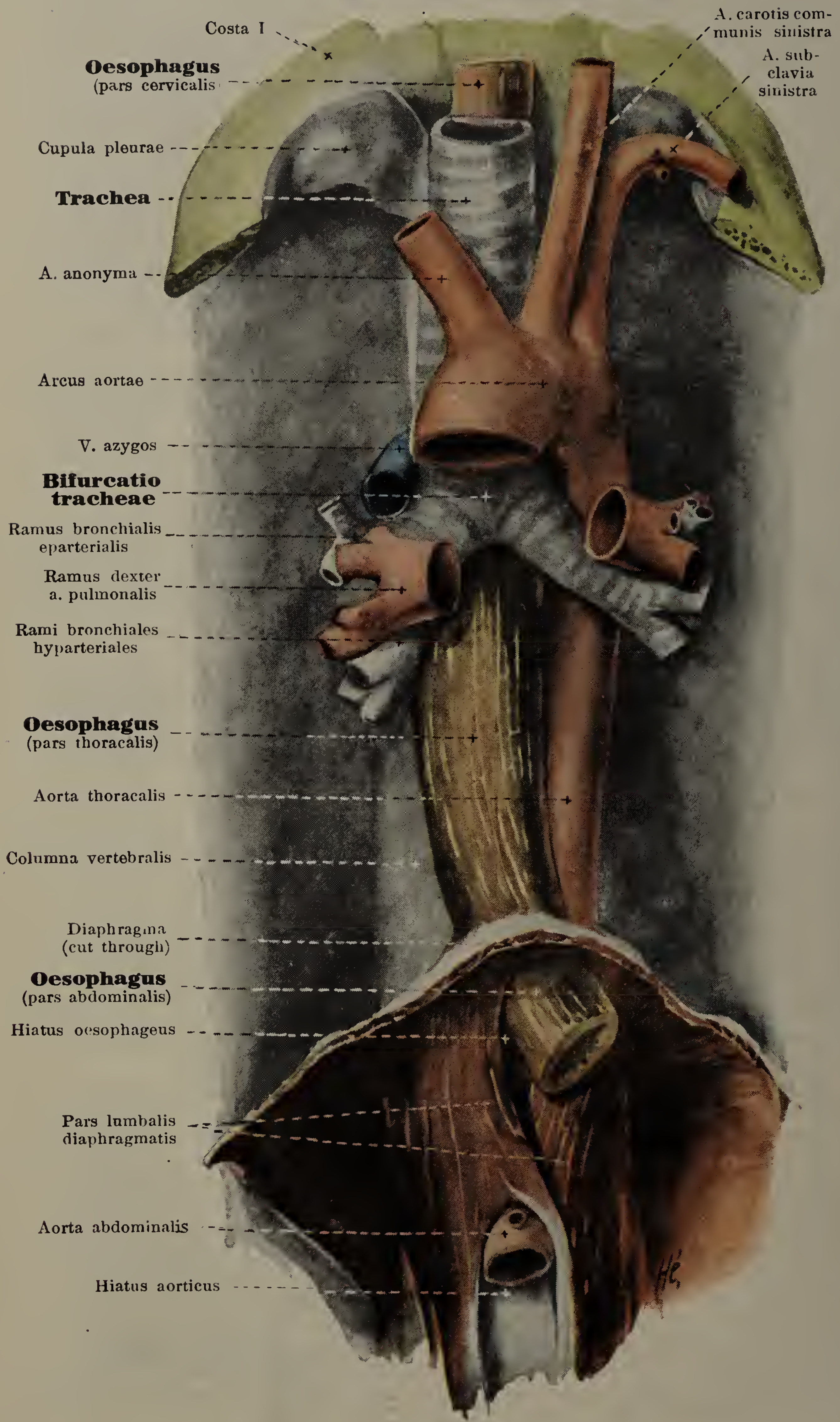
1. *M. thyreopharyngeus.* Origin: lateral surface of the lamina cartilaginis thyreoideae (linea obliqua).
2. *M. cricopharyngeus.* Origin: from a tendinous arch convex backward, which is stretched out between the tuberculum thyreoideum inferius and the lateral surface of the cartilago cricoidea and partially bridges over the m. cricothyreoideus (see p. 572), and from the lateral surface of the cartilago cricoidea.

The upper, larger mass of fibres forms a loop around the posterior margin of the cartilago thyreoidea and runs medianward and upward, diverging somewhat. The inferior bundles of fibres extend more horizontally but so that they mostly form convex arches with the fibres of the other side; these arches are curved partly upward, partly downward; those which are curved downward fuse with the circular muscle layer of the oesophagus between the bundles of origin of the longitudinal muscle fibres of the oesophagus as these converge below.

Action of the constrictor muscles of the pharynx: they narrow the pharynx. Innervation: rami pharyngei n. vagi.

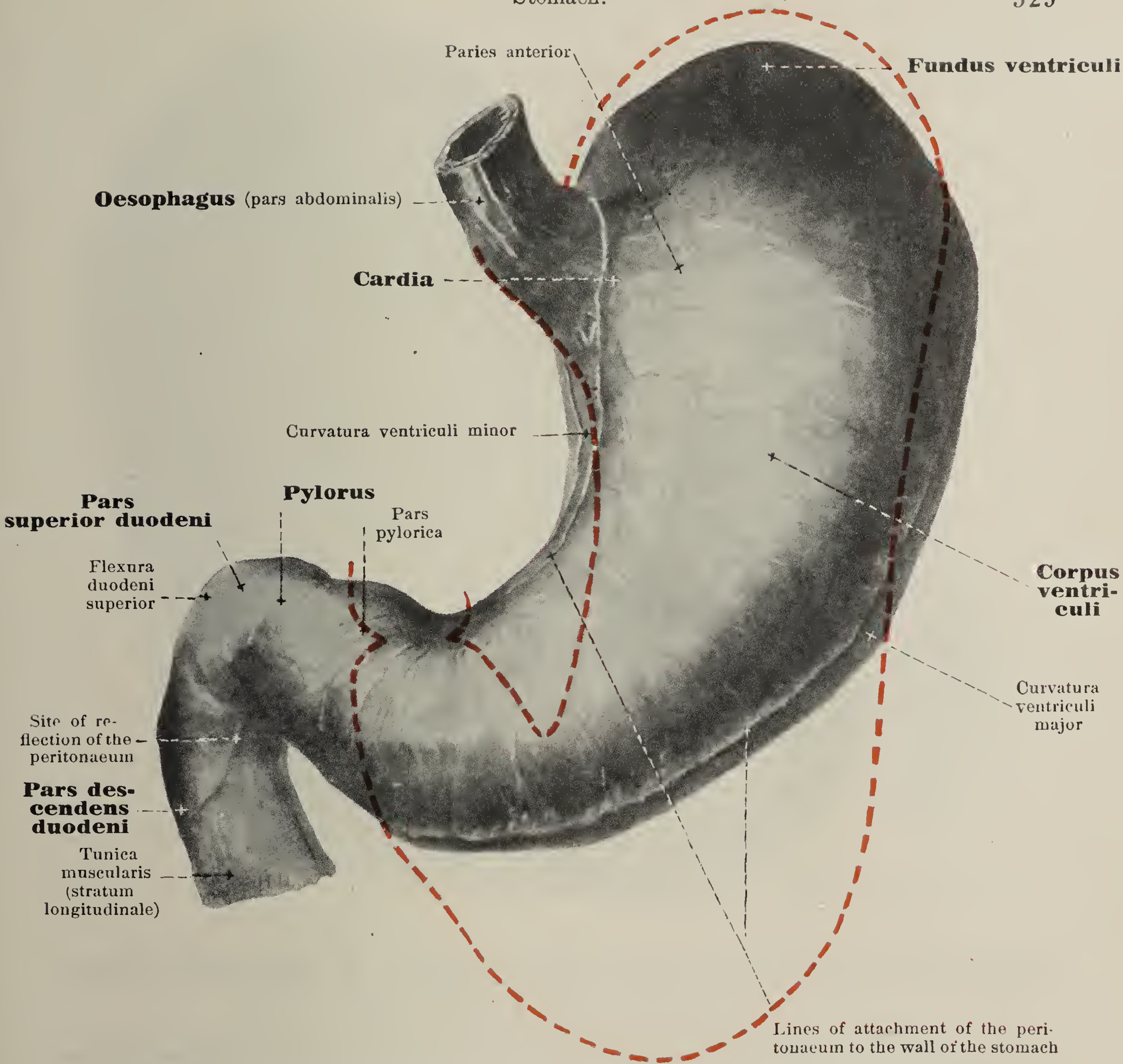
M. stylopharyngeus (see Figs. 582, 602, 605 and 606). Form: slender, flattened. Position: above it is situated between the m. constrictor pharyngis superior and the m. stylohyoideus, as well as between the a. carotis interna and externa, below in the wall of the pharynx medianward from the mm. constrictores pharyngis medius et inferior. Origin: root of the processus styloideus. Insertion: it extends downward and medianward and, diverging in front of the upper margin of the m. constrictor pharyngis medius, sinks into the wall of the pharynx. A part of the fibres extends medianward at the posterior wall, the other part runs farther downward and (see Fig. 602) arrives in front of the m. pharyngopalatinus partly in the plica pharyngoepiglottica to the anterior surface of the epiglottis, partly in the plica aryepiglottica to the m. aryepiglotticus (see p. 575) and the thyroid and cricoid cartilage, partly (see Figs. 602 and 605) to the upper margin of the lamina cartilaginis thyreoideae. Action: it widens the pharynx and elevates the pharynx and larynx. Innervation: rami pharyngei n. vagi (see farther p. 733).

607. Oesophagus and trachea with surrounding tissues, viewed from in front.


Costa I
Oesophagus (pars cervicalis)
Cupula pleurae
Trachea
A. anonyma
Arcus aortae
V. azygos
Bifurcatio tracheae
Ramus bronchialis eparterialis
Ramus dexter a. pulmonalis
Rami bronchiales hyparteriales
Oesophagus (pars thoracalis)
Aorta thoracalis
Columna vertebralis
Diaphragma (cut through)
Oesophagus (pars abdominalis)
Hiatus oesophageus
Pars lumbalis diaphragmatis
Aorta abdominalis
Hiatus aorticus
A. carotis communis sinistra
A. subclavia sinistra
Hé

(The pleura with the exception of its uppermost part has been removed on each side.)

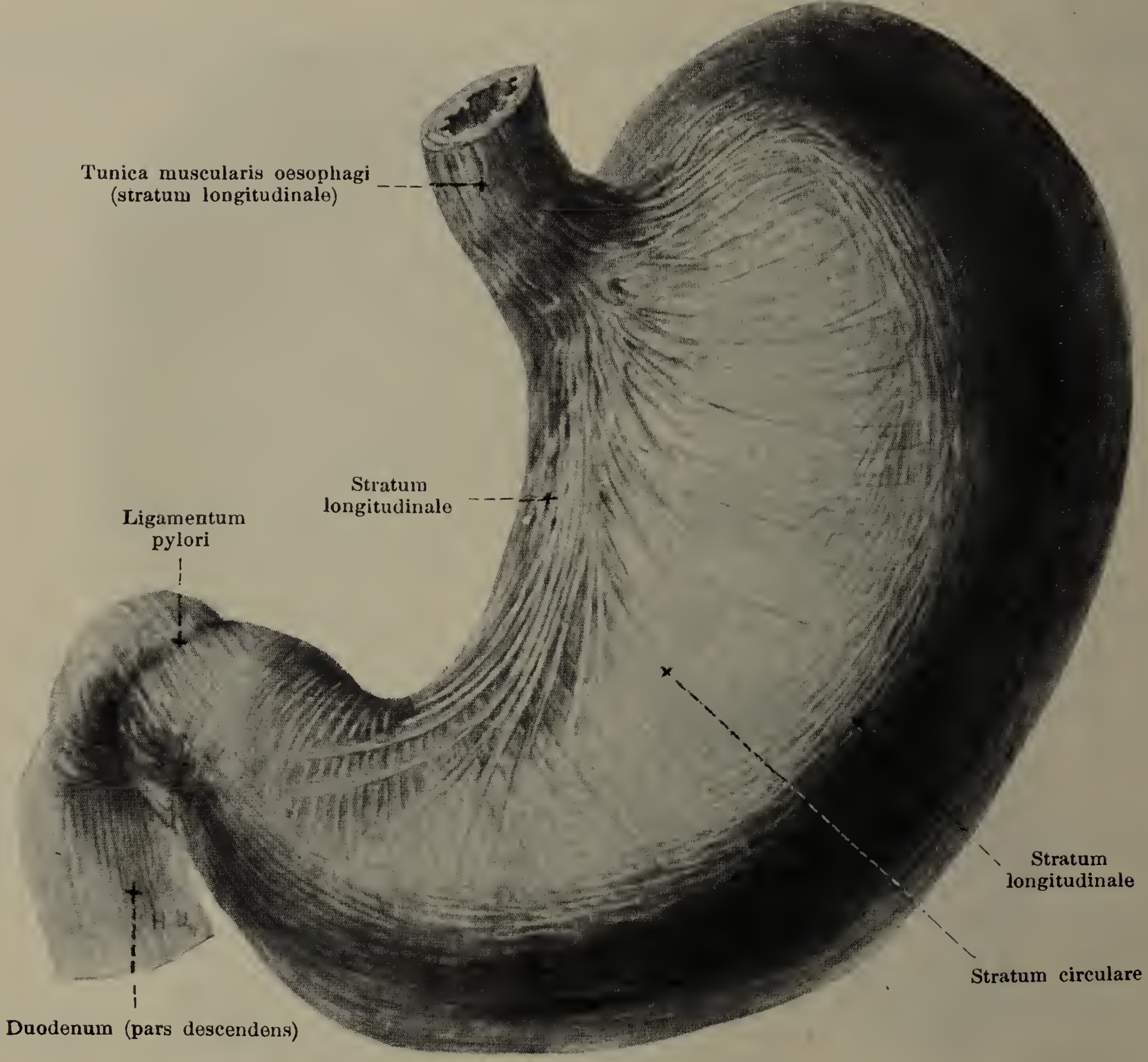
The **oesophagus** *(gullet)* (see also Figs. 358, 563, 567, 600, 608 and 681—683) is a muscular tube and in man averages 25 centimetres in length. It begins as the continuation of the pharynx behind the cartilago cricoidea, in front of the 6th cervical vertebra *(pars cervicalis)*, runs downward through the spatium mediastinale posterius of the thorax *(pars thoracalis)*, passes through the hiatus oesophageus diaphragmatis into the abdominal cavity *(pars abdominalis)* and opens into the cardia of the stomach at the level of the 10th—12th thoracic vertebra.


Paries anterior
Fundus ventriculi
Oesophagus (pars abdominalis)
Cardia
Curvatura ventriculi minor
Pars superior duodeni
Pylorus
Pars pylorica
Flexura duodeni superior
Corpus ventriculi
Curvatura ventriculi major
Site of reflection of the peritonaeum
Pars descendens duodeni
Tunica muscularis (stratum longitudinale)
Lines of attachment of the peritonaeum to the wall of the stomach

608. The Stomach, nearly empty, viewed from in front.

(The red line indicates the form and position of the distended stomach. After C. Elze.)

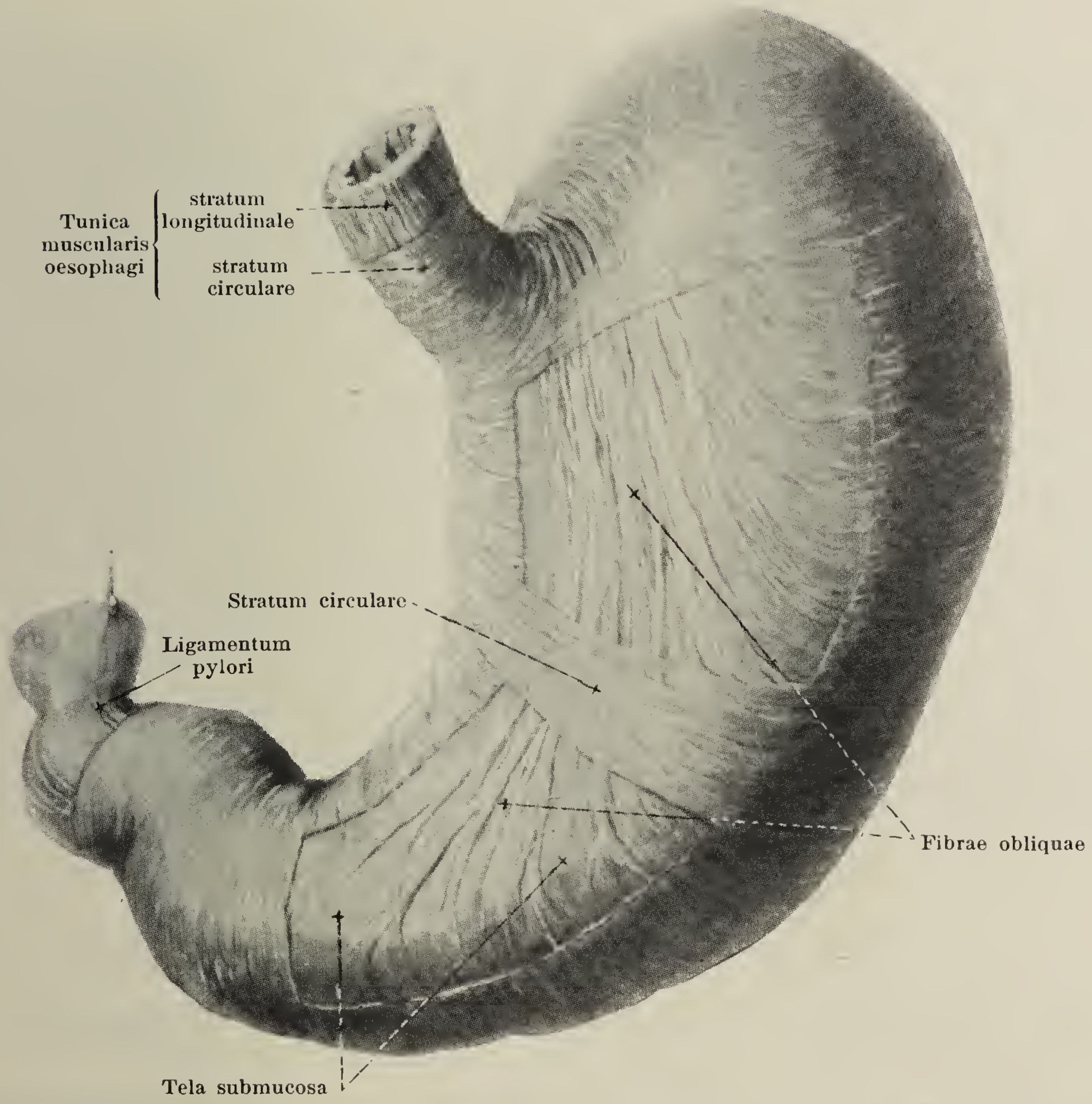
Oesophagus (see also Figs. 358, 563, 567, 600, 607 and 681—683) (continued). In its course it lies, with the exception of its lowermost portion, directly in front of the spinal column, in its upper half also behind the trachea, in the lower part of the pars thoracalis behind the pericardium and the left atrium. It runs nearly straight in front of the middle of the spinal column, deviating above a little to the left, in the middle a little to the right where it passes on the right anterior surface of the aorta thoracalis, and on the left side of the v. azygos; in the lowermost part of the pars thoracalis it extends, turned slightly to the left and forward, on the anterior surface of the aorta and goes in front of this, somewhat to the left of the median plane, obliquely through the diaphragm. In the middle part of the pars thoracalis the oesophagus, especially its posterior wall, lies for a long distance close to the pleura mediastinalis dextra (see Fig. 683), in the lowermost part it approaches for a short distance very close to the pleura mediastinalis sinistra (see Fig. 681). The pars abdominalis is very short and runs to the left and downward in front of the pars lumbalis diaphragmatis, directly behind the impressio oesophagea of the liver. The oesophagus when empty is markedly flattened above from before backward, its lumen being a frontally placed slit; in the whole thoracic portion it is wide open during life. Its diameters increase on the average from above downward; circular constrictions can however be made out, oftenest in three situations: behind the cartilago cricoidea, behind the bifurcatio tracheae and in the hiatus oesophageus of the diaphragm; the uppermost is very frequently the narrowest.


Tunica muscularis oesophagi (stratum longitudinale)
Stratum longitudinale
Ligamentum pylori
Stratum longitudinale
Stratum circulare
Duodenum (pars descendens)

609. Superficial muscular layer of the stomach, viewed from above and in front.

The *wall of the oesophagus* consists of three layers. Inside lies the mucous membrane, *tunica mucosa*, of a grayish-red to a whitish color; beneath it is the connective tissue, *tela submucosa*. Throughout the latter are mucous glands, *glandulae oesophageae*, varying in number and size; at the upper and lower end of the oesophagus however the mucous membrane possesses in addition a variable quantity of glands which agree in their structure with the glands of the stomach. The outermost layer, *tunica muscularis*, is composed of an inner circular and an outer longitudinal layer (see also Figs. 593, 605, 606 and 610). The bundles of the latter arise from the posterior surface of the cartilago cricoidea, surround in part the oesophagus and spread out upon the whole circumference of the latter. On the relation of these layers to the cardia see pp. 532 and 533. The longitudinal layer is connected usually by very variable narrow bands of fibres (not illustrated) with the posterior surface of the trachea, of the left bronchus *(m. bronchooesophageus)*, with the pleura mediastinalis sinistra *(m. pleurooesophageus)* and with the muscle fibres which surround the hiatus oesophageus of the diaphragm.

The **stomach** *(ventriculus, gaster)* (see also Figs. 563, 608 and 611) is an unpaired, saccular dilatation of the alimentary canal connecting above with the oesophagus, below with the duodenum. In it can be distinguished an upper surface directed at the same time forward and to the right *(paries anterior)* and a lower surface directed at the same time backward and to the left *(paries posterior)*; these go over into one another to the right and behind at the shorter *curvatura ventriculi minor*, and to the left and in front at the longer, considerably curved *curvatura ventriculi major*, on which run the main-stems of the gastric vessels. At the upper end of the curvatura minor the oesophagus enters the wall of the stomach *(cardia)*; the blind-sac-like portion projecting higher up and situated to the left of the cardia is called the *fundus (fornix) ventriculi*. The middle and largest part is called *corpus ventriculi*. The corpus is usually continued into the *expulsion canal* or *pars pylorica* very frequently by a right-angled or acute-angled bend, which often causes a distinct furrow at the curvatura minor.



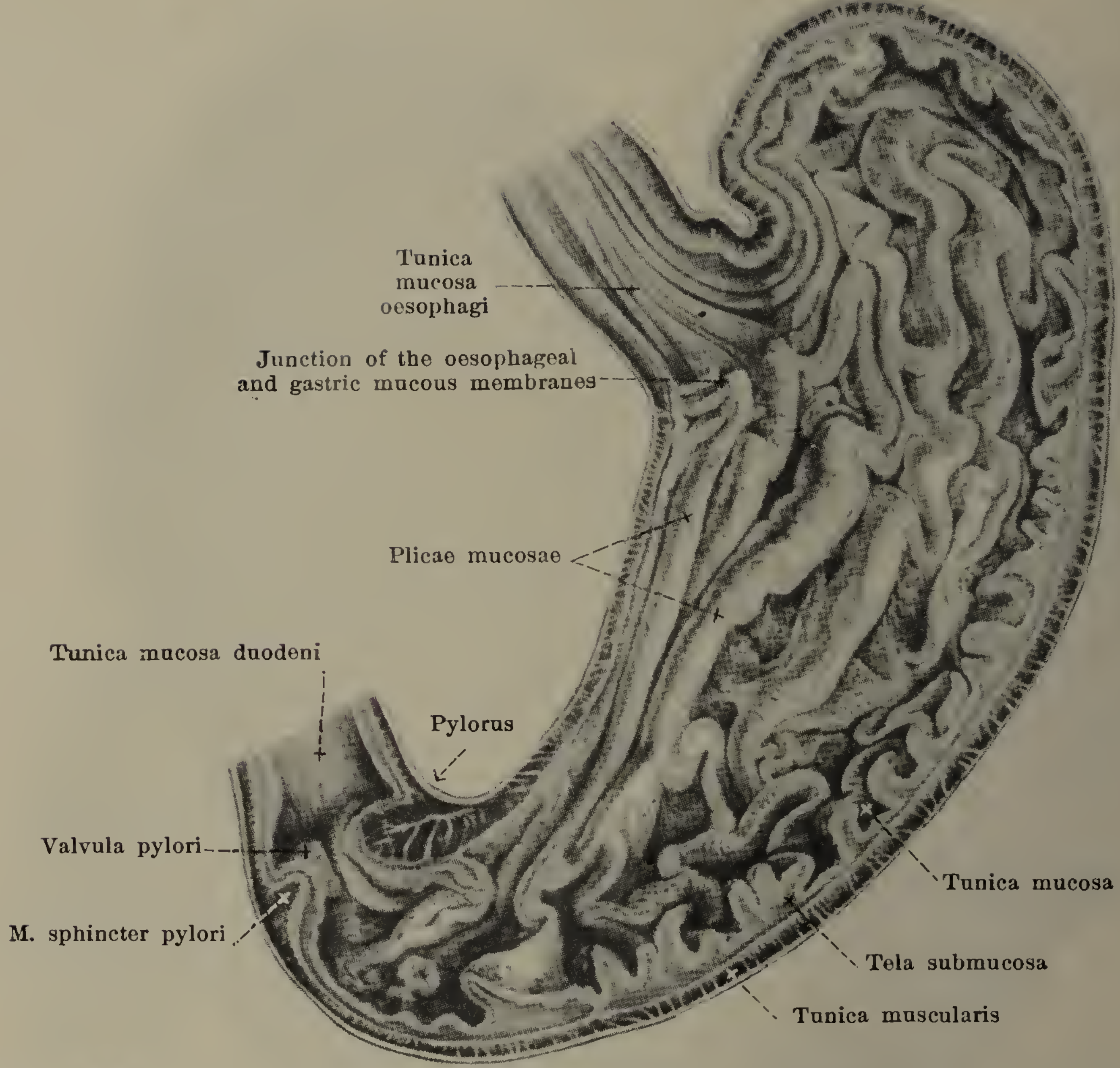
610. Middle and deep muscular layers of the stomach, viewed from above and in front.

(The superficial layer has been completely, the middle partly, cut away.)

Stomach (continued). The pars pylorica is approximately cylindrical in shape and may be separated from the duodenum by a ring-formed constriction, which indicates the position of the *pylorus.*

The form of the stomach (and partly also its position) varies very considerably in the living, and depends particularly on the volume of its contents and on the position of the body. The empty, contracted stomach looks like an intestine, but is somewhat wider above than below. When the stomach is filled the pars pylorica changes only very little in shape; but on the other hand fundus and corpus distend from the curvatura minor both to the left and downward, so that the angular bend of the pars pylorica increases and the stomach assumes the shape of a bow („fish-hook-shape“) when the body is in vertical position.

Position of the stomach (s. Figs. 516, 548 and 642—644). The main portion of the stomach lies on the left side of the body. A plane passing through the two curvatures looks forward and slightly to the right and upward. In this plane the stomach lies in the form of a semi-ring or loop, convex to the left, below and in front, curved around the pars lumbalis of the diaphragm, around the tuber omentale of the pancreas and around the tuber omentale and the processus papillaris of the liver. The upper portion of the curvatura minor extends pretty constantly almost vertically to the left crus mediale of the diaphragm. The pars pylorica in the contracted stomach and in recumbent position extends almost transversely to the right and backward; in the distended stomach, and in upright posture, obliquely to the right upward and backward, or upward and backward. The lowest point of the stomach when in the form of a bow (see above) may reach as far as below the navel. The pylorus is always situated above the caudal part; it lies farther forward than the cardia. In recumbent position it lies usully on the right hand side of the 1st lumbar vertebra and in vertical position as a rule at the level of the 3rd—4th lumbar vertebra.



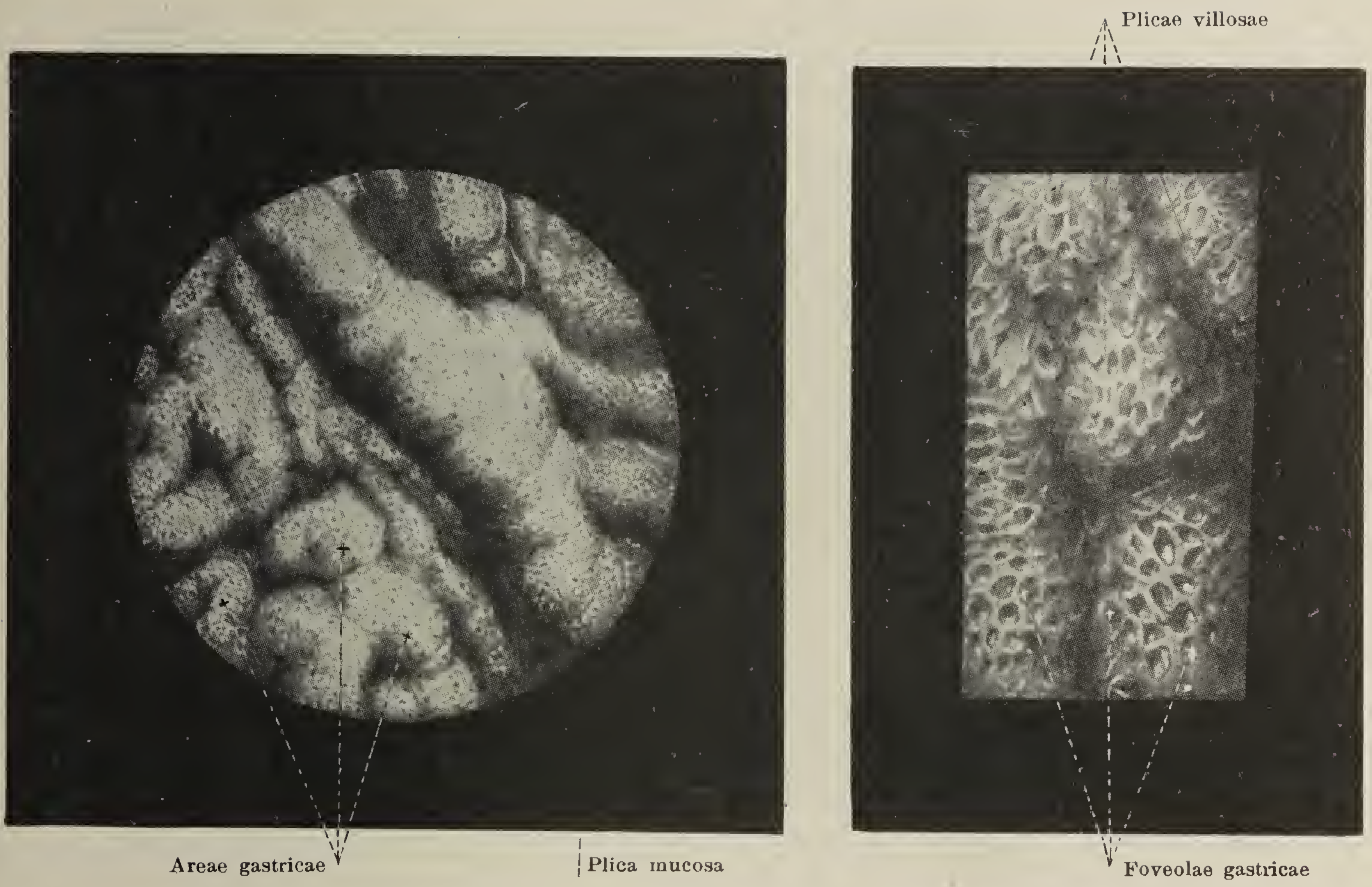
611. Mucous membrane of the stomach,
posterior half, viewed from above and in front.

(The moderately distended stomach has been cut through along the greater and lesser curvatures.)

Position of the stomach (continued) (see Figs. 643 and 644). The fundus is bounded directly above by the cupola of the diaphragm, to the left and behind by the facies gastrica of the spleen. The paries posterior is in contact with the facies anterior of the glandula suprarenalis sinistra, with the facies anterior (impressio gastrica) of the left kidney, with the facies anterior of the pancreas and with the mesocolon transversum; it is partly separated from these organs by the bursa omentalis. The paries anterior is in contact with the impressio gastrica of the lobus sinister and of the lobus quadratus as well as with the tuber omentale of the liver and, when the stomach is empty, is almost completely covered by these parts. When the stomach is full the paries anterior is in contact on the left side in still greater extent with the diaphragm; in addition, a triangular area of the corpus and pars pylorica lies directly against the anterior abdominal wall in the regio epigastrica beneath the margo anterior of the left lobe of the liver and to the right of the 8th (and 9th) costal cartilage of the left side (see Fig. 642).

The external surface of the stomach is covered by the ***tunica serosa (peritoneal coat)*** (see Fig. 608). Two narrow strips running from the cardia to the pylorus alone remain free from it. One of these extends along the curvatura minor; near it is attached the ligamentum hepatogastricum. The other stretches behind the fundus and along the curvatura major; near it goes off the lig. gastrolienale, the omentum majus and the lig. gastrocolicum.

Beneath the peritoneal covering lies the ***tunica muscularis.*** It consists of three layers. The outermost layer, *stratum longitudinale* (see Fig. 609), is a continuation of the longitudinal muscle fibres of the oesophagus. It forms a narrower, more powerful, complete band of fibres along the curvatura minor, while a broader but feebler band passes over the fundus and the greater curvature; in addition fibres diverge from the cardia to the corpus. The bundle running along the curvatura minor, becomes, after divergence of the fibres to the pars pylorica, very thin. The pars pylorica possesses a closed outer layer of longitudinal muscle fibres, which only to a very slight degree extend over the duodenum; the most of them bend into the depth at the pylorus. The bundles upon the anterior and posterior surfaces of the pars pylorica are especially tense and closely arranged and are designated the *ligamenta pylori.*



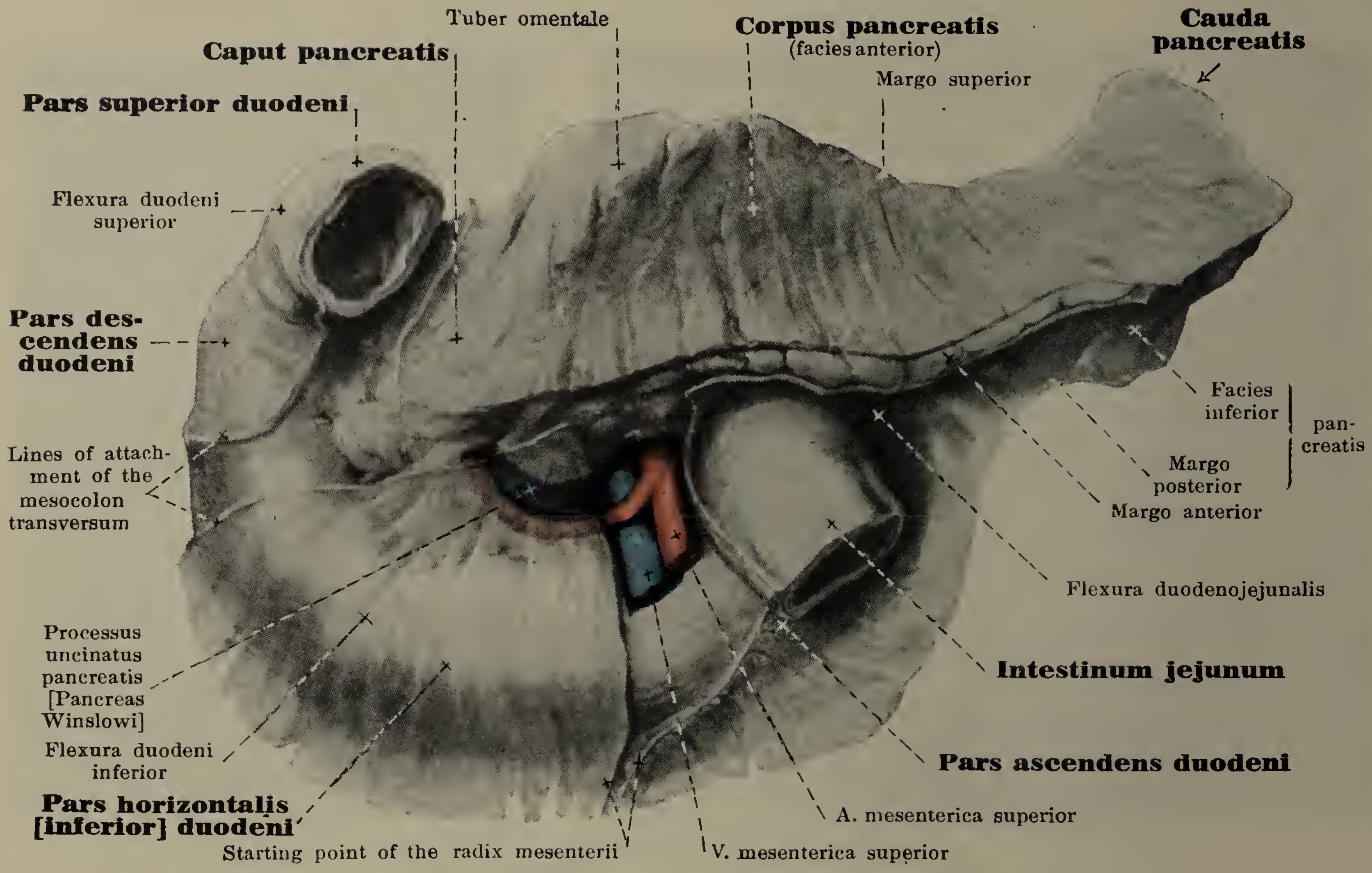
612 and 613. Mucous membrane of the stomach,

from the pars pylorica, viewed from the surface.

Magnification: 5 : 1. Magnification: 16 : 1.

The **stomach.** ***Tunica muscularis*** (continued). The second layer of the same, *stratum circulare* (see Figs. 609 and 610), in the form of even circular bands of fibres covers the whole stomach with the exception of the fundus; the uppermost fibres arising at the right side of the cardia form only incomplete rings. The layer is directly connected with the circular layer of the oesophagus and of the duodenum and projects at the pylorus into the interior of the stomach as an especially thickened ring, *m. sphincter pylori* (see Fig. 611). The third, deepest layer, *fibrae obliquae* (see Fig. 610), is connected at the left side of the cardia with the circular layer of the oesophagus. Thence the fibres diverge upon the paries anterior and posterior so that the first run parallel to the curvatura minor and pass almost as far as the pars pylorica, the last run more transversely to the long axis; all the fibres bend around finally in the direction of the stratum circulare and are partly continued into this. To these fibres are added, on the left side and above, those which encircle the fundus in concentric rings.

The ***tunica mucosa*** *(mucous membrane)* of the stomach (see also Fig. 611) is separated from the tunica muscularis by the *tela submucosa.* It is of a grayish-red or rose color and is marked off at the cardia by a sharp jagged line from the more whitish mucous membrane of the oesophagus. When the stomach is contracted it forms with the tela submucosa numerous folds, the *plicae mucosae* (O. T. rugae). Longitudinal folds are found along the curvatura minor (which may also be free from folds) and in the pars pylorica; in other places the folds are arranged in an irregular network. These folds vanish entirely when the stomach is markedly distended. At the pylorus there is always a fold, usually circular, the *valvula pylori,* which is shoved forward by the m. sphincter pylori and surrounds an opening, which when relaxed is just large enough to receive the tip of the 4th finger. Besides the larger folds of the stomach there are still smaller elevations, *areae gastricae,* incompletely separated from one another by a large number of irregular furrows of varying depth; they differ markedly from one another and each has an area of several square millimeters. Over the whole mucous membrane with the aid of a hand-lens can be seen minute depressions, *foveolae gastricae,* in which open the glands of the stomach, *glandulae gastricae [propriae]* and *glandulae pyloricae.* The thin walls intervening between these depressions present, especially in the pars pylorica, small, oblong, flat villous processes, the *plicae villosae.*

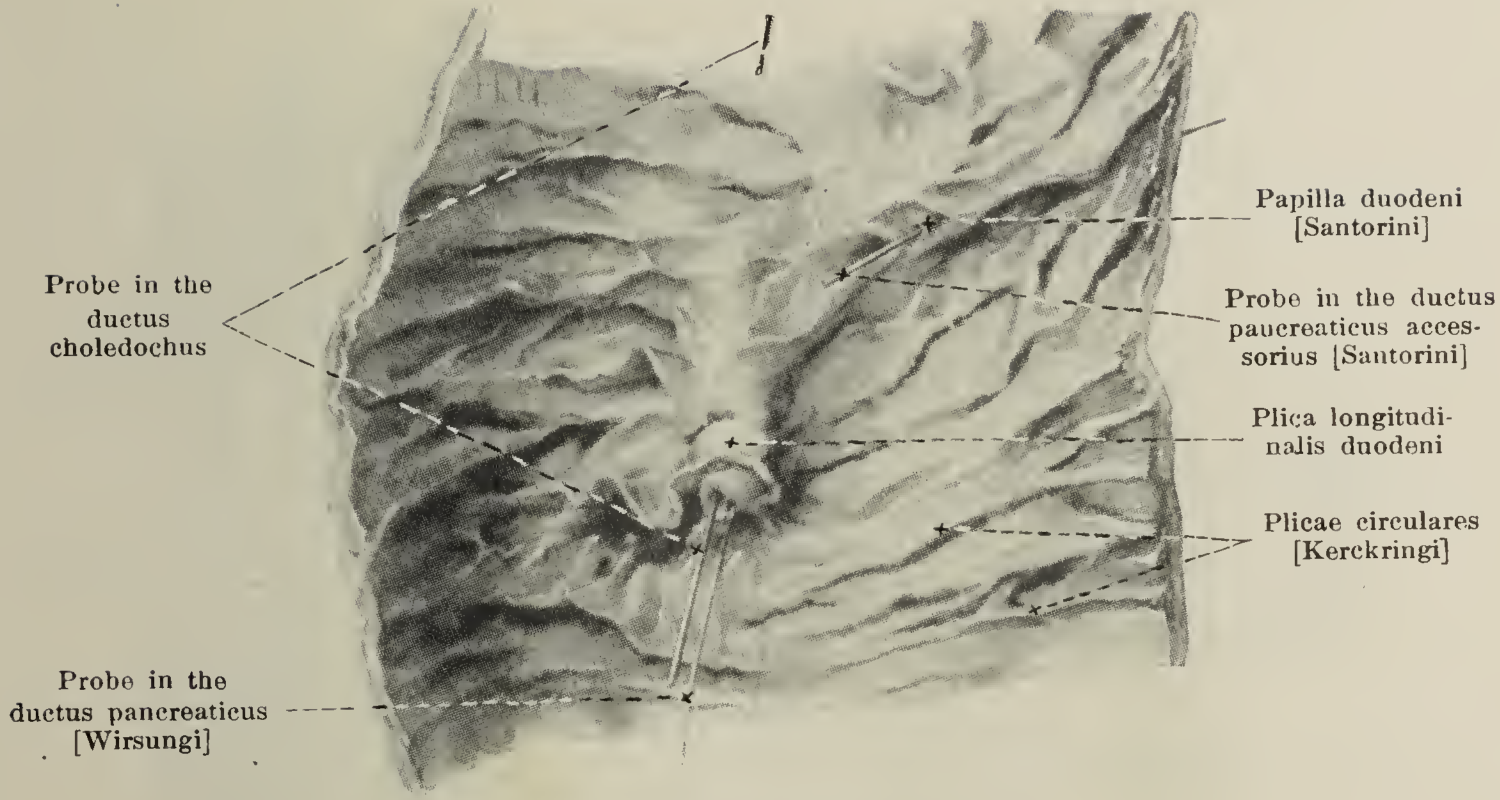


614. Duodenum and pancreas, viewed from in front.

(A piece of the pars superior duodeni has been cut off. The peritonaeum has been cut away exactly at the point where it turns away from the two organs.)

The **small or thin intestine** *(intestinum tenue)* (see Fig. 563) is a cylindrical tube; it begins at the pylorus, fills up a large part of the abdominal and pelvic cavities with its numerous convolutions and ends by opening into the large intestine. Its length is in adults generally 5—7 metres and its diameter gradually diminishes from above downward. The small intestine is divisible into the *duodenum* and the *intestinum tenue mesenteriale.*

The ***duodenum*** (see also Figs. 635, 636 and 642—645) is the name given to the first portion of the small intestine which is directly and firmly attached to the posterior abdominal wall. It forms a spirally curved ring, open to the left and above, in the concavity of which the pancreas is inserted and the terminal points of which lie closer to one another when the stomach is empty than when it is full. It presents for examination a *pars superior, pars descendens* and *pars inferior.* The *pars superior* is the shortest portion and runs approximately horizontally and backward in recumbent position, obliquely cranialward and backward in upright posture; it extends at the same time, more or less distinctly, from left to right. It lies to the right and in front of the pars lumbalis of the diaphragm, of the v. portae, a. hepatica and ductus choledochus, behind and below the lobus quadratus of the liver, crosses the porta hepatis and by means of the *flexura duodeni superior* bends around beneath the processus caudatus of the liver into the *pars descendens.* This runs downward and somewhat to the left in front of the medial margin of the right kidney (somewhat nearer the median plane when the colon ascendens is full than when it is empty), to the right of the v. cava inferior, behind the left portion of the right lobe of the liver, behind the gall-bladder and behind the colon transversum and goes over by means of the *flexura duodeni inferior* into the *pars inferior.* The latter extends transversely to the left at first *(pars horizontalis [inferior])* in front of the body of the 3rd or 4th lumbar vertebra and in front of the v. cava inferior and then turns abruptly upward and somewhat to the left *(pars ascendens)* in front of the aorta abdominalis. This last portion runs behind the a. and v. mesenterica superior, crossed by the radix mesenterii, as far as the left side of the body of the 2nd lumbar vertebra and as far as the facies inferior pancreatis and there, covered by the stomach, suddenly bends around markedly to the right and forward *(flexura duodenojejunalis),* to go over into the intestinum jejunum. Sometimes no marked pars horizontalis inferior is present; the pars descendens then forms a **V** with the pars ascendens.


Probe in the ductus choledochus
Papilla duodeni [Santorini]
Probe in the ductus pancreaticus accessorius [Santorini]
Plica longitudinalis duodeni
Plicae circulares [Kerckringi]
Probe in the ductus pancreaticus [Wirsungi]

615. Mucous membrane of the pars descendens of the duodenum.

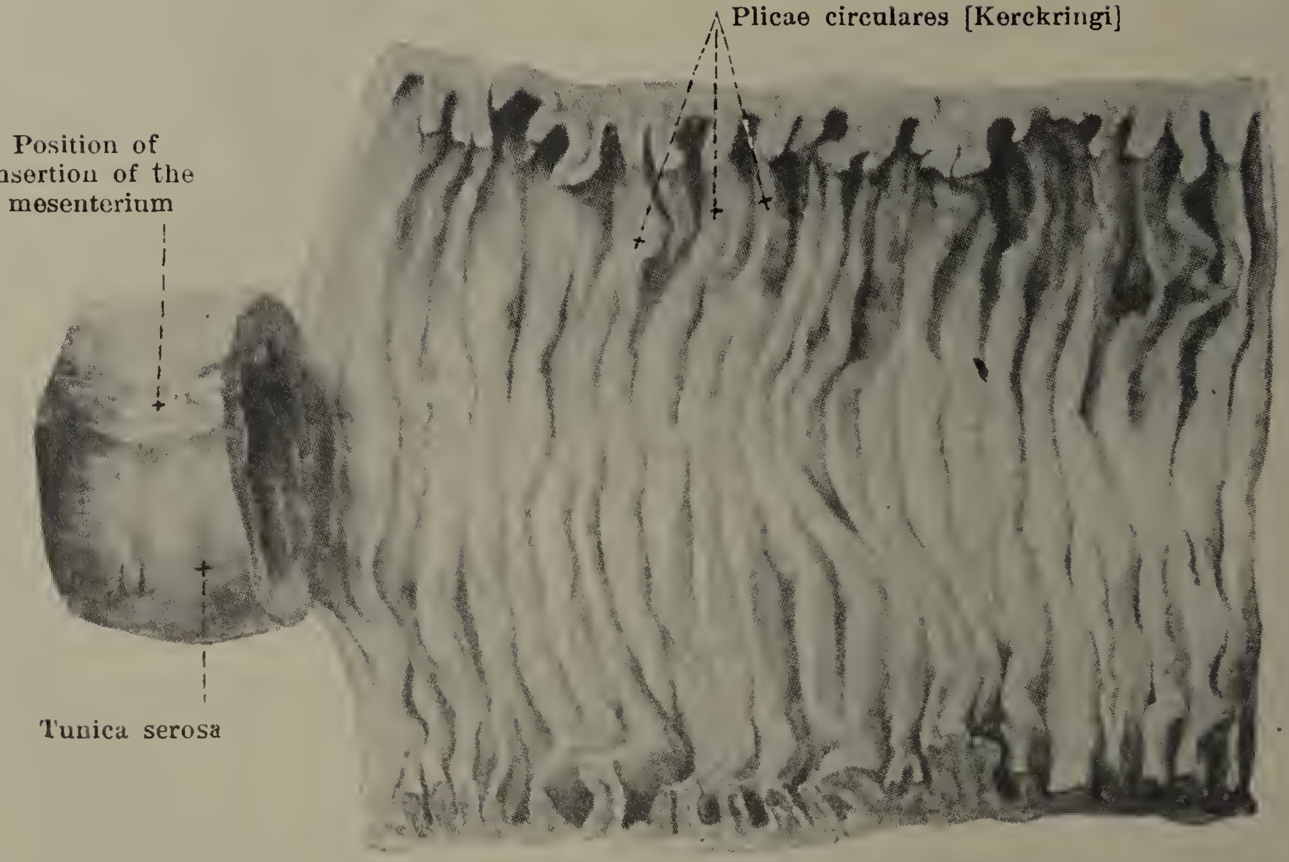
(The piece of intestine has been cut open along its right side and spread out.)

Duodenum (continued). The flexura duodenojejunalis is firmly attached to the diaphragm by means of the *m. suspensorius duodeni* (see Fig. 686). This small, flat, triangular muscle consisting of smooth muscle fibres arises directly above the hiatus aorticus from the bands of fibres of the pars lumbalis diaphragmatis. It runs downward in front of the plexus coeliacus and behind the pancreas, its fibres diverging downward; it lies to the left of the a. coeliaca and a. mesenterica superior and is strengthened by fibres from the neigborhood; at the flexure it radiates out into the longitudinal and circular muscle bands of the intestine.

The *tunica serosa (peritoneal covering)* is present only in part of the duodenum (see Figs. 614, 644 and 645). A part of the left wall of the pars superior looks into the bursa omentalis and is covered by its peritonaeum; the right and upper walls are completely covered by peritonaeum, the latter except for a narrow strip, from which the ligamentum hepatoduodenale goes off. The pars descendens possesses a serous covering on its right and anterior walls, and only the area between the lines of attachment of the mesocolon transversum is free from it. The pars horizontalis [inferior] is covered by peritonaeum in front and below, the pars ascendens in front and to the left, the latter with the exception of the spot where it is crossed by the radix mesenterii.

The *tunica muscularis* in detail, the *tunica mucosa* in general, resembles that of the rest of the small intestine. But the mucous membrane possesses in the pars descendens certain special structures in addition (see also Fig. 635). In that region, at the junction of the posterior with the left wall, it is elevated by the ductus choledochus to a longitudinal fold more distinct below, the *plica longitudinalis duodeni;* in its lower part this presents a small projection upon which open the ductus choledochus and the ductus pancreaticus [Wirsungi] either close to one another with two openings or, when they have previously united, by a common opening. Somewhat above and in front of this spot there is constantly to be found a smaller rounded elevation, *papilla duodeni [Santorini]*, with the opening (sometimes missing) of the ductus pancreaticus accessorius [Santorini].

The ***intestinum tenue mesenteriale*** (see Figs. 563 and 640) by means of numerous convolutions fills up the space which is bounded on the right by the colon ascendens, above by the colon transversum and mesocolon transversum, to the left by the colon descendens; it is shoved into the right and left partly in front of the organs mentioned and extends below into the cavity of the small pelvis. In the posterior wall of this space, covered by the peritonaeum, lie the bodies of the two inferior lumbar vertebrae, the lower part of the pars descendens and the pars inferior duodeni, the processus uncinatus of the pancreas and the large abdominal vessels, as well as, on each side, parts of the mm. iliopsoas et quadratus lumborum, the kidney and the ureter. In front and lateralward the small intestine is covered to a variable extent by the great omentum (see Fig. 639) and is separated by this from the peritoneal covering of the m. transversus abdominis and of the mm. recti abdominis.


Plicae circulares [Kerckringi]
Position of insertion of the mesenterium
Tunica serosa

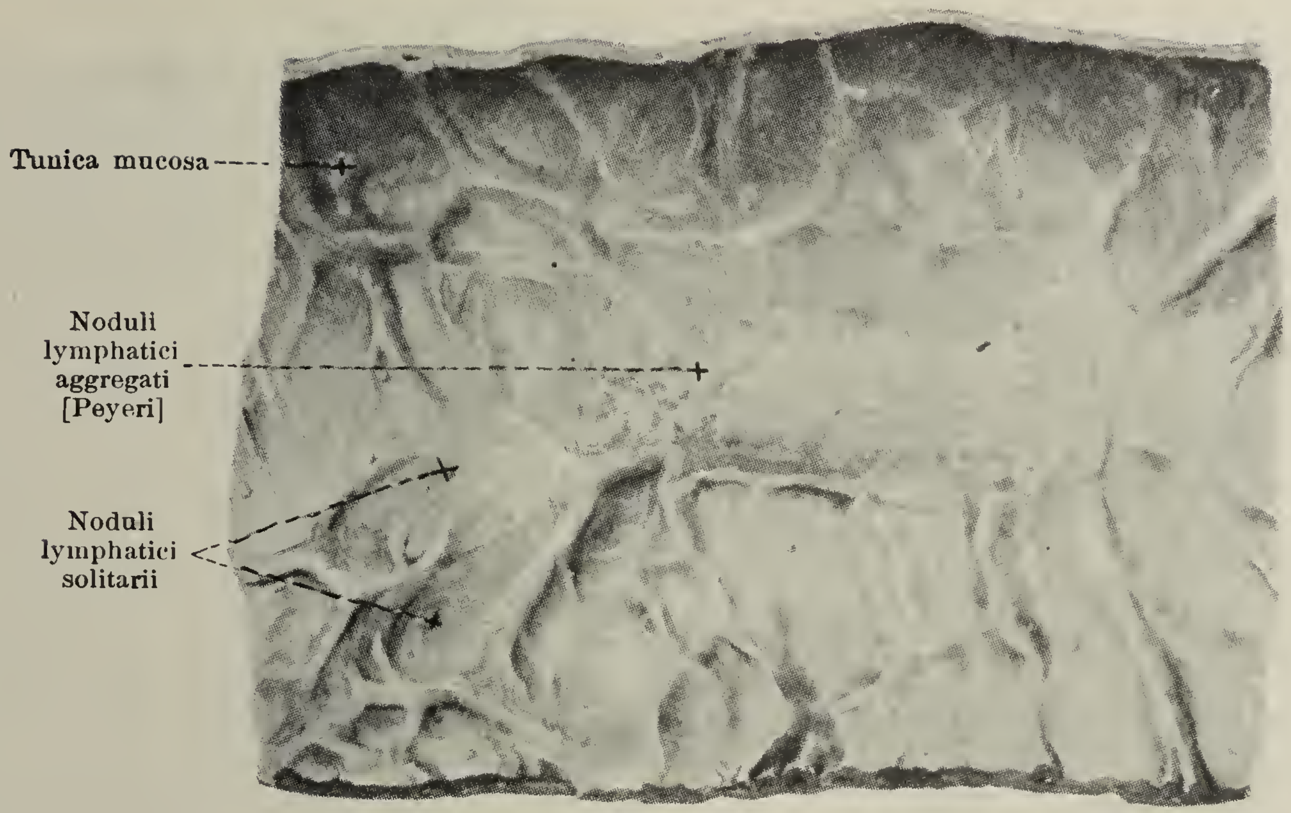
616. Portion of the intestinum jejunum,

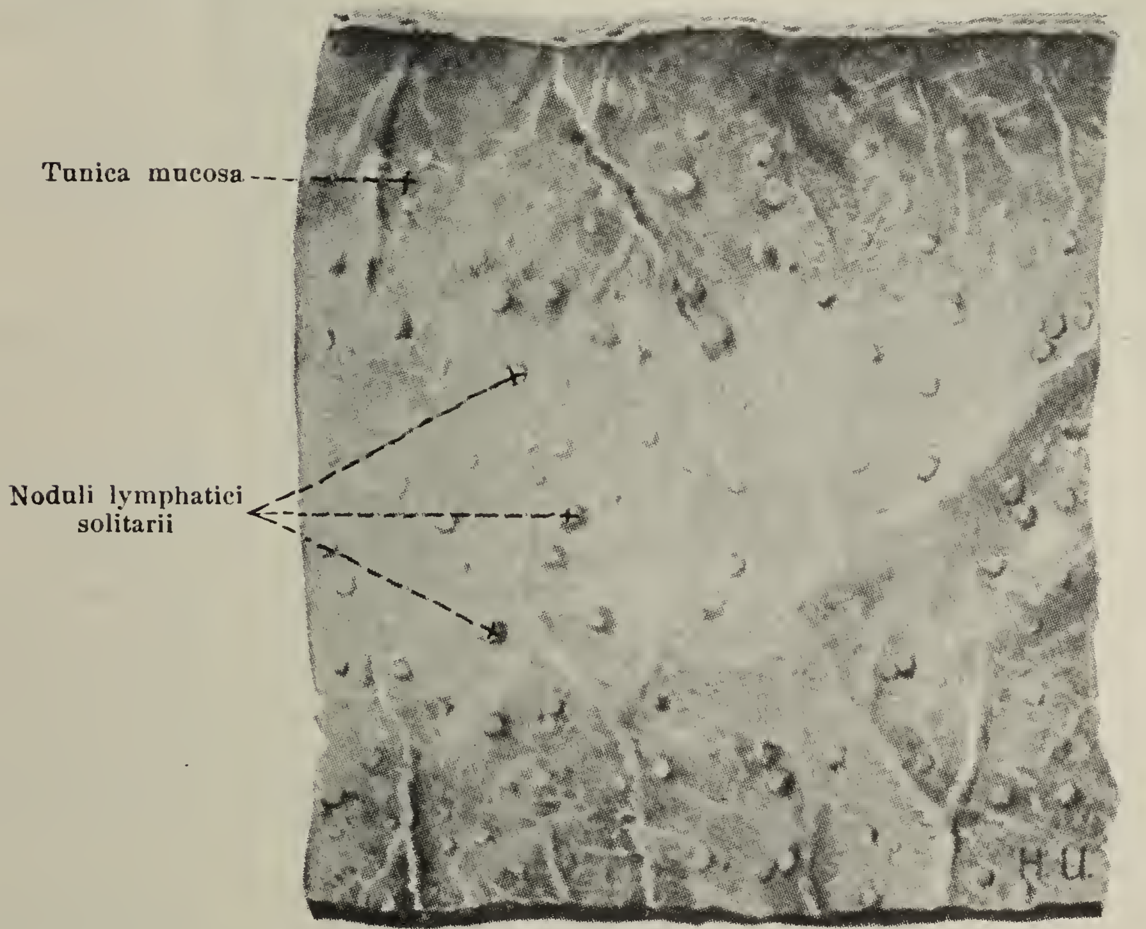
in part cut open at the attachment of the mesentery and spread out.

Of the ***intestinum tenue mesenteriale*** about the upper half is called the ***intestinum*** *jejunum* (empty intestine), the lower is called the ***intestinum ileum*** (convoluted intestine); a sharp limit between the two however exists neither on the external nor on the internal surface. The general arrangement is very frequently as follows (see Figs. 563, 640 and 641): the first portion lies in the regio hypochondriaca sinistra with two groups of loops, which reach above as far as the flexura coli sinistra and are partly covered by the colon transversum; the intestine then passes through the regio umbilicalis turning into the right half of the body, curves around there and runs backward again across the median plane; thereupon it forms several loops in the left fossa iliaca, extends to the right again and finally descends into the small pelvis, where it fills up with its loops the cavity which is lined by the peritonaeum; its terminal portion passes upward again, curves to the right around the margin of the right m. psoas major and passes in the fossa iliaca into the colon ascendens (see also Fig. 624). Deviations from this course are frequent.

The external covering of the intestinum tenue mesenteriale is formed by the delicate *tunica serosa (peritoneal coat)* (see also Fig. 619), which leaves free only a narrow strip where the mesenterium is attached to the intestine. The second layer of the wall consists of the *tunica muscularis;* this is composed of a thinner, external, less complete longitudinal layer, *stratum longitudinale*, and of a thicker, internal, continuous circular layer, *stratum circulare* (see Fig. 619). The innermost layer, *tunica mucosa (mucous membrane)* is separated from the preceding by the *tela submucosa* (see Fig. 619). In the duodenum the latter contains the glandulae duodenales [Brunneri] (not illustrated) and throughout the whole length of the intestine the bodies of the noduli lymphatici; it sends stripe-like continuations into the plicae circulares [Kerckringi]. The mucous membrane is of a reddish color and presents the following special structures:

a) *Plicae circulares [Kerckringi]* (O. T. valvulae conniventes) (see also Fig. 619), are constant folds, which are formed by the mucous membrane and the tela submucosa. They are absent in the pars superior duodeni, appear in the pars descendens duodeni and are especially numerous and large in the pars inferior duodeni and in the upper third of the intestinum jejunum; farther on they diminish again and are usually completely absent in the lowermost portion of the intestinum ileum. They run approximately at right angles to the long axis of the intestine and extend usually over only a part of the circumference; a number of folds forms complete rings and others encircle the intestine in a spiral turn (more rarely in several). In the upper part of the intestine they are longer and higher than in the lower part. The folds are manifoldly forked; neighboring ones are also frequently united with one another by low, slender folds.


Tunica mucosa
Noduli lymphatici aggregati [Peyeri]
Noduli lymphatici solitarii

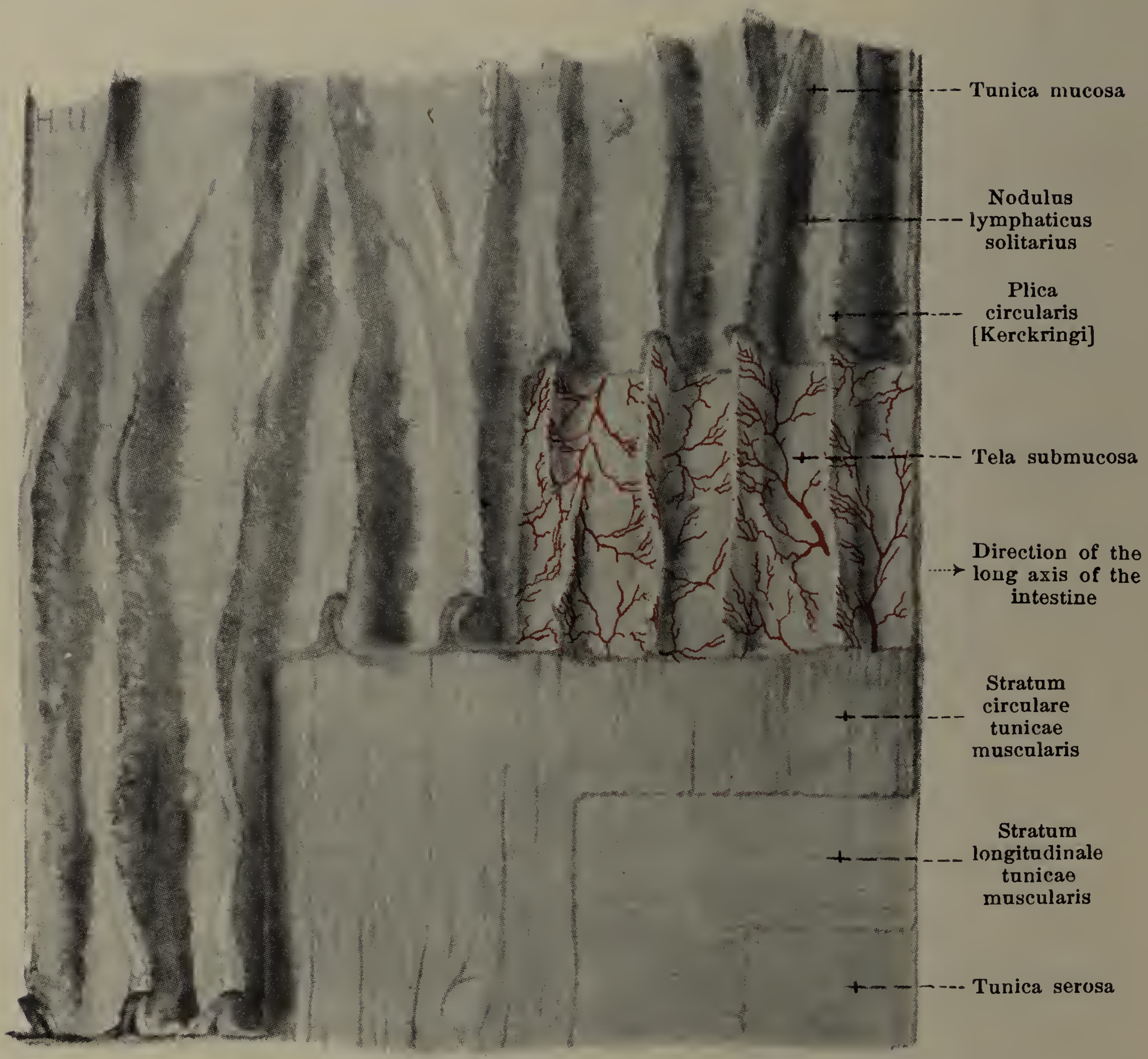


617 and 618. Portions of the intestinum ileum,

cut open at the insertion of the mesenterium and spread out.

(The upper figure shows an intestine with many groups of lymph nodules (Peyer's patches). the lower an intestine in which the groups of lymph nodules are only slightly developed and are replaced by an increased number of solitary nodules.)

b) *Noduli lymphatici (lymph nodules)* (see also Figs. 619—621) are small, usually pear-shaped structures, whose thick bodies are situated in the tela submucosa; the blunt wedge-shaped apex of each lies in the tunica mucosa and forms a (non-villous) dome-like elevation of the surface of the mucous membrane. They are usually single in the intestinum jejunum *(noduli lymphatici solitarii).* In the intestinum ileum they are numerous and much higher and in part are crowded together into oblong *Peyer's patches (noduli lymphatici aggregati [Peyeri]);* these vary in size but generally contain from twenty to thirty nodules; they lie opposite the insertion of the mesenterium; these patches may be replaced in part by an increased number of solitary nodules.


Tunica mucosa
Nodulus lymphaticus solitarius
Plica circularis [Kerckringi]
Tela submucosa
Direction of the long axis of the intestine
Stratum circulare tunicae muscularis
Stratum longitudinale tunicae muscularis
Tunica serosa

619. The wall of the small intestine. Magnification: 3 : 2.

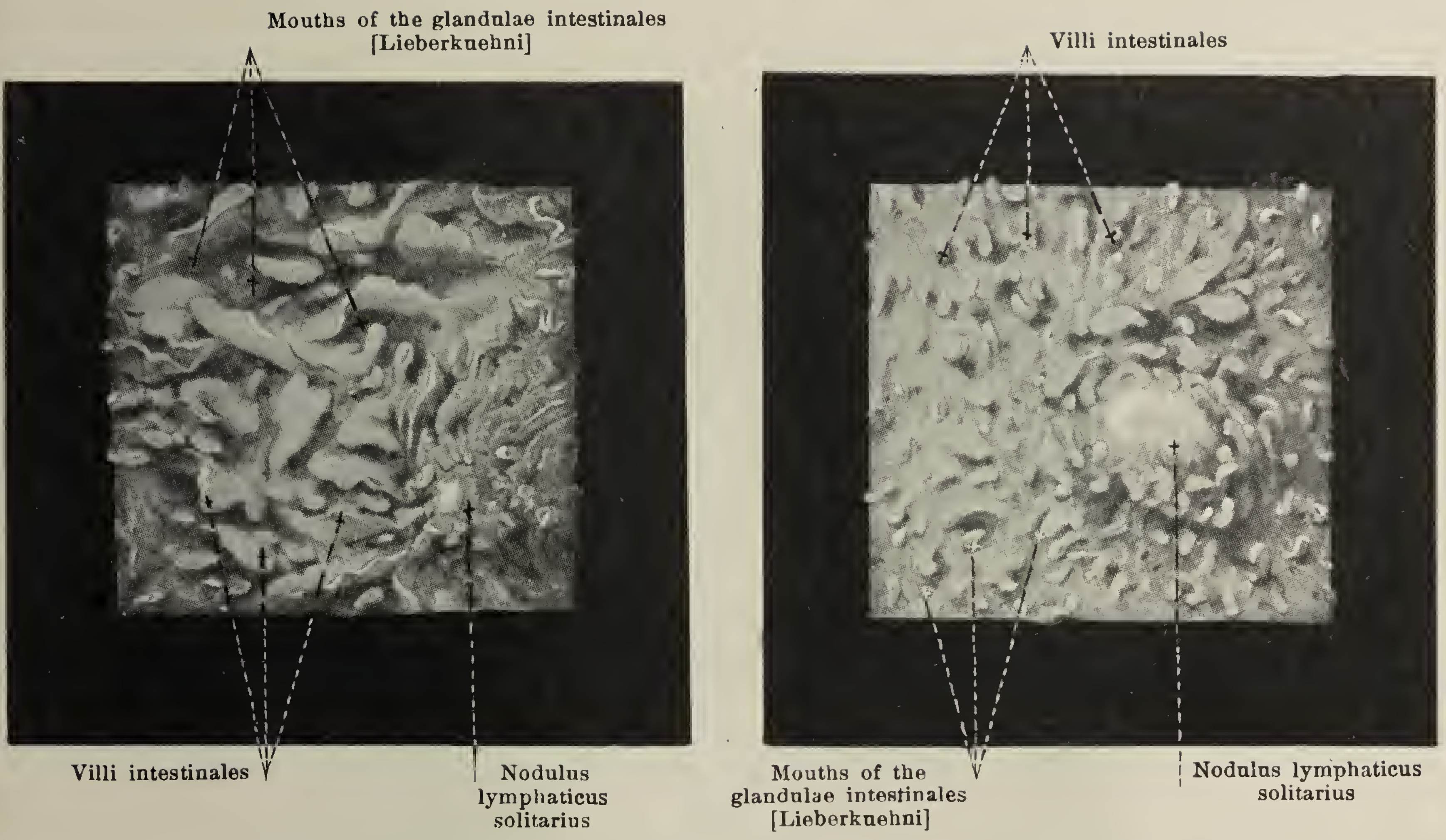
(Passing from above downward the individual layers have been gradually removed.)

c) *Villi intestinales* (villi of the intestine) (see Figs. 620 and 621) are small elevations (the largest being 1 mm long) of the surface of the mucous membrane which are present from the pylorus almost as far as the free margin of the valvula coli and are closely crowded upon the plicae circulares [Kerckringi] and between them. They leave free only the domes of the noduli lymphatici and are somewhat more numerous in the upper than in the lower part of the intestine. In the upper part of the intestine they are also much broader, more leaf-like, in the lower part more slender, cylindrical or flattened; along with these however all possible intermediate forms occur.

d) *Glandulae intestinales [Lieberkuehni]* (O. T. crypts of Lieberkuehn) (not illustrated) are tube-like glands which are studded over the mucous membrane perpendicularly to the surface throughout the whole extent of the small and large intestines. With the hand-lens their mouths are visible as small openings (see Figs. 620, 621 and 628).

e) *Glandulae duodenales [Brunneri]* (Brunner's glands of duodenum) (not illustrated) are glands which are found in the duodenum only; the main bodies of the glands are situated in the tela submucosa while the ducts extend between the glandulae intestinales [Lieberkuehni] through the tunica mucosa to its surface. The glands are largest and most numerous in the pars superior duodeni; farther on they gradually become less numerous and vanish entirely at the level of the flexura duodenojejunalis.

The **large or thick intestine** *(intestinum crassum)* (see Figs. 640—642), following upon the small intestine, is the most variable portion of the digestive tube. It begins as the *intestinum caecum* in the fossa iliaca dextra, surrounds a part of the peritoneal cavity and the small intestine with a large loop, which ends in the fossa iliaca sinistra and in which we distinguish an ascending *(colon ascendens)*, a transverse *(colon transversum)* and a descending limb *(colon descendens)*. Its terminal portion *(colon sigmoideum)* hangs as a loop generally down into the cavity of the small pelvis (see p. 544) and goes over in front of the sacrum into the rectum. It is on an average about 1½ metres long. The portion from the caecum to the rectum is called the *colon (griping intestine)*.


Mouths of the glandulae intestinales [Lieberkuehni]
Villi intestinales
Nodulus lymphaticus solitarius
Villi intestinales
Mouths of the glandulae intestinales [Lieberkuehni]
Nodulus lymphaticus solitarius

620 and 621. Villi of the small intestine,

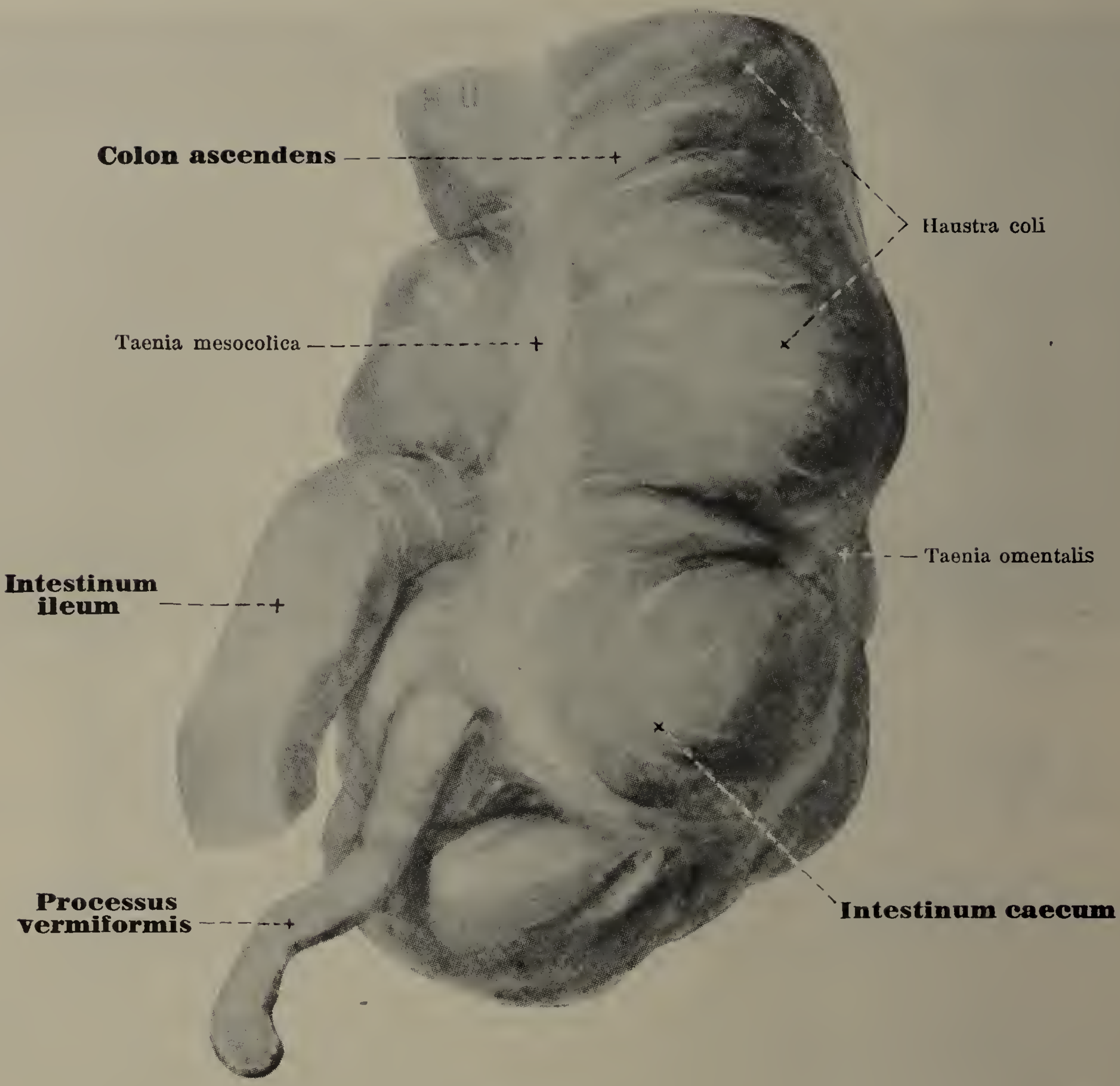
from the upper part of the intestine. from the lower part of the intestine.

Magnification: 12 : 1.

The large intestine is characterized (see Figs. 622, 623 and 625) by the fact that its surface is not smoothly cylindrical but presents a nodular appearance due to three rows of irregular, flask-like projections, *haustra coli.* These rows of haustra are separated from one another by three band-like strips of the longitudinal muscle (see p. 545), *taeniae coli,* which run in the long axis of the intestine, but they are besides individually further subdivided by furrows of varying depth which correspond to sickle-shaped folds on the surface of the mucous membrane, the *plicae semilunares coli.* The diameter of the large or thick intestine is larger than that of the small intestine, but diminishes gradually toward its termination. The distention of the large intestine with faeces usually diminishes from the caecum toward the rectum, so that the colon descendens is usually empty and collapsed; the colon sigmoideum is, on the contrary, often distended by gas or faeces.

The ***intestinum caecum*** *(blind gut)* (see Figs. 622—625) is the blind-sac-like portion of the large intestine situated below the opening of the intestinum ileum into the large intestine. Its upper boundary is indicated externally by a deep incomplete groove which surrounds the intestine at the level of this opening and to which internally the frenula valvulae coli correspond. The contracted caecum (see Fig. 623) forms a kink in this furrow with the colon ascendens, so that it runs to the left, downward and backward; its haustra are but little marked and it has the shape of a wedge, from the apex of which the processus vermiformis goes off with more or less distinct narrowing, at first in the direction of the main tube. The distended caecum (see Figs. 622, 624, 625 and 647) forms a less marked kink with the colon ascendens and is directed downward and a little to the left. It is approximately hemispherical in shape and has well marked haustra. The processus vermiformis goes off directly from the medial part of the posterior wall. The three taeniae coli extend toward the beginning of the processus vermiformis; in the contracted intestine they converge gradually as they approach, in the distended they meet one another in the form of a T.

The *processus vermiformis* (O. T. *vermiform appendix)* (see Figs. 622—625 and 647) is a narrow, generally cylindrical, hollow, blind-ending appendix of the intestinum caecum, the length, curvature and position of which vary extraordinarily; it is on an average 8½ centimetres long. From its origin behind and beneath the termination of the small intestine it runs straight or tortuous toward the small pelvis or upward behind the caecum or to the left and upward behind the small intestine, or often in some other direction. Its position varies correspondingly; it is covered in its course partly or entirely by the caecum. It is covered externally by a continuous layer of longitudinal muscle. The processus vermiformis often becomes partly or entirely obliterated in the later years of life.



622. Caecum, distended,

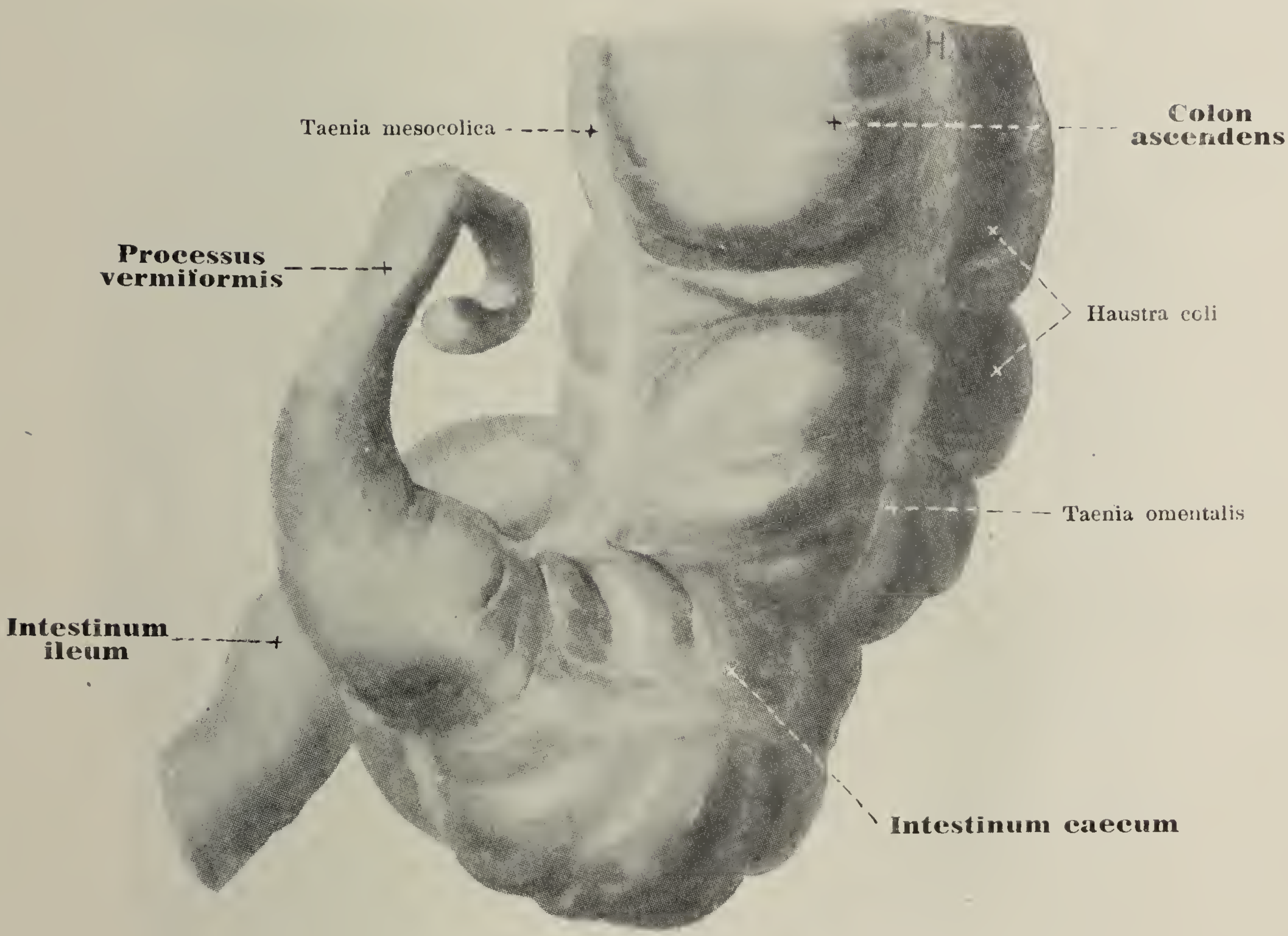
viewed from behind, after removal of the peritoneal coat.

Position of the caecum (see Figs. 640—642). The caecum rests in the fossa iliaca dextra directly upon the fascia iliaca, separated by this from the m. iliopsoas: When it is full its lower end lies just over the lateral half of the right ligamentum inguinale; its right wall is in contact with the lateral wall of the abdominal cavity; its anterior wall is overlapped below and to the left by small intestines and is directly in contact above and to the right with the anterior abdominal wall; its left wall may reach the left margin of the right m. psoas major and the right vasa iliaca externa. In the contracted condition the lower end does not reach so far downward and the anterior wall is completely covered in front by loops of small intestine.

The *wall of the caecum* consists like that of the whole of the large intestine of *tunica serosa, tunica muscularis, tela submucosa* and *tunica mucosa.*

The *tunica serosa (peritoneal coat)* (see Figs. 624 and 647) covers the caecum and the vermiform appendix almost completely in by far the majority of cases; it leaves free only a narrow strip which extends from the orifice of the small intestine to near the tip of the vermiform process (see p. 565) and along this the mesenteriolum processus vermiformis is attached to the intestine. Sometimes only the inferior portion of the posterior wall is covered by the peritonaeum; the upper part then has the same relations as the colon ascendens.

The *tunica muscularis* resembles that of the rest of the large intestine (see p. 545).

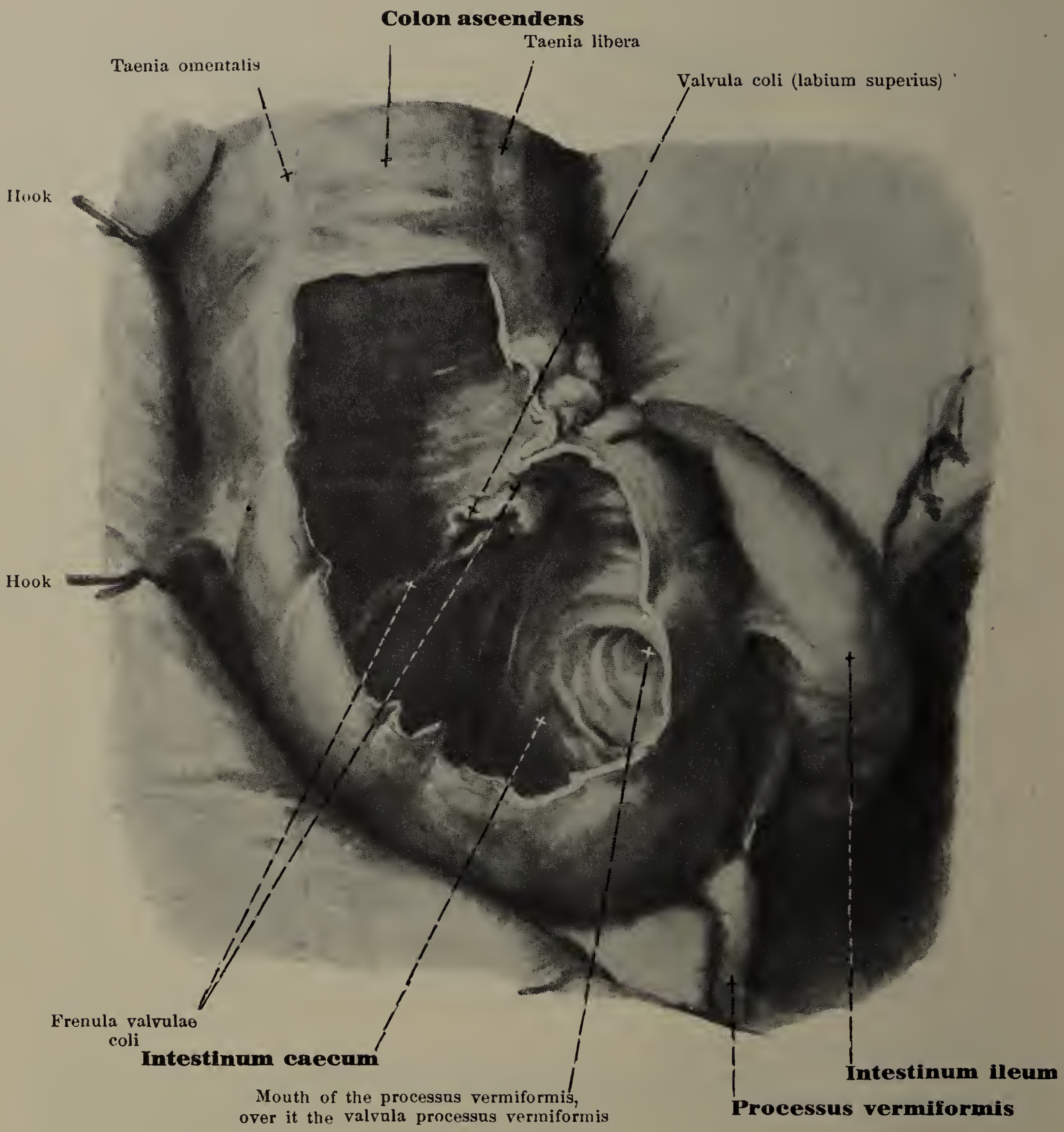


623. Caecum, contracted,

viewed from behind, after removal of the peritoneal coat.

Wall of the caecum (continued):

The ***tunica mucosa (mucous membrane)*** (see Figs. 624 and 625) presents fossa-like depressions which correspond to the haustra, and plicae semilunares which correspond to the constrictions on the external surface. The funnel-shaped opening of the processus vermiformis is sometimes surrounded on the left and above by a sickle-shaped fold of mucous membrane ***(valvula processus vermiformis)***. At the upper limit of the caecum in the posterior part of the left wall lies the opening of the small intestine within the ***valvula coli (valve of the large intestine)***. In the formation of this the terminal portion of the small intestine is invaginated into the cavity of the large intestine (see Fig. 625), its external wall being fused for a certain distance with that of the large intestine. There thus arise two high folds formed by the walls of the small and large intestines, the ***labium superius*** and ***labium inferius*** of the valvula coli, of which the lower may be shorter than the upper. Both folds go over into one another at their ends and surround the opening of the small intestine proper by their projecting margins. This opening is slit-shaped and its longitudinal diameter is usually directed from the left and above to the right and downward. From the point of union of the two folds there goes off in front and behind a high fold of mucous membrane of the large intestine, the ***frenulum valvulae coli;*** the two frenula have in common with the labium superius a sickle-like form, run from the left and above to the right and downward and extend over more than half the circumference of the intestine; the posterior frenulum is the longer and broader. They correspond to the deep furrow on the outer surface at the level where the caecum forms a kink with the large intestine (see p. 539). The valve of the large intestine is said to be always insufficient in the newly born, in children and adults it is normally sufficient. Regarding the mucous membrane see farther p. 545.



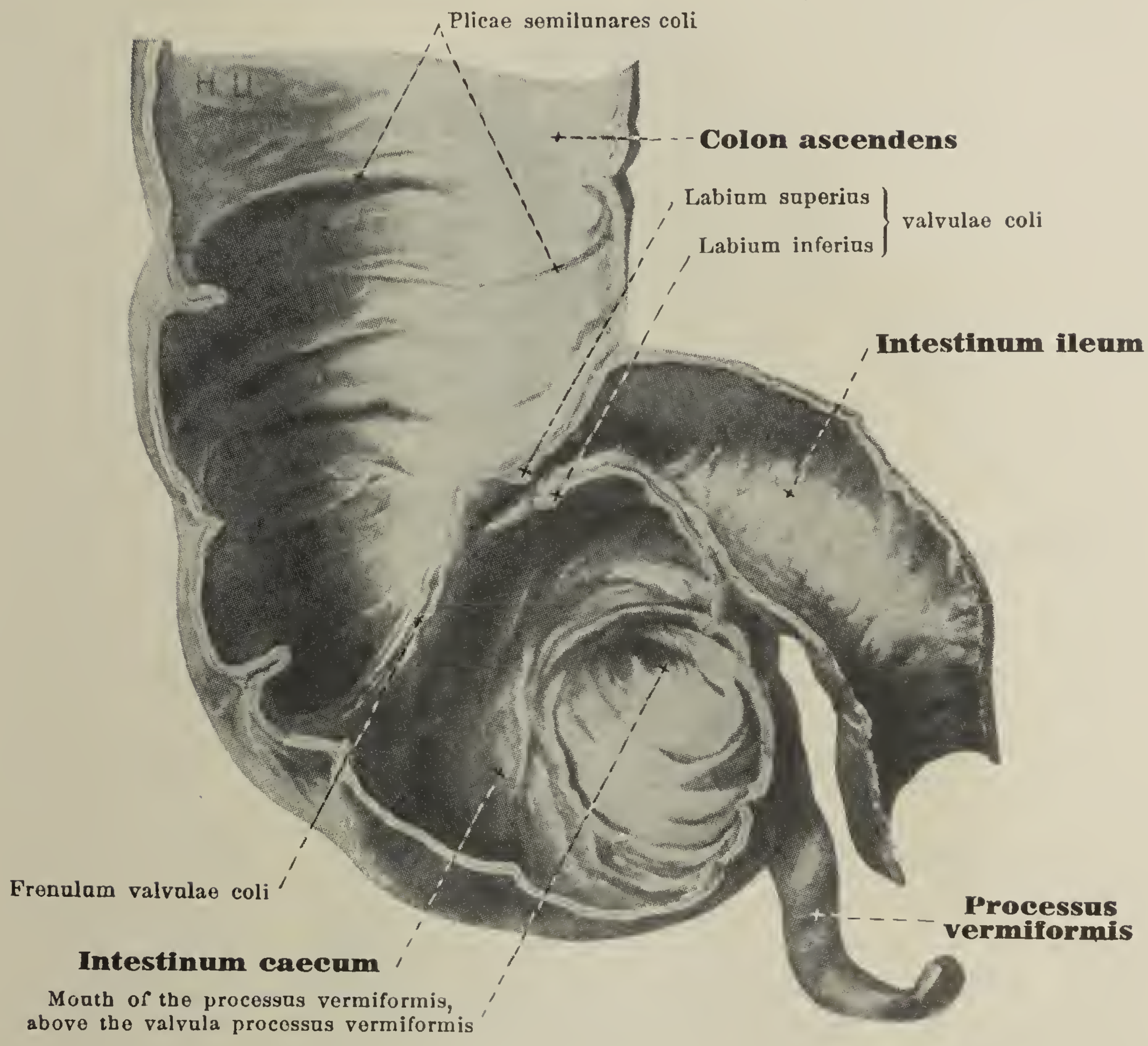
624. Caecum, distended, ***in situ,***

partly opened from in front.

(The anterior abdominal wall has been reflected to the right and downward; the small intestines have in large part been removed.)

The ***colon ascendens*** (see also Figs. 640—643) begins at the frenula valvulae coli as the direct continuation of the caecum; it passes upward and somewhat backward from the fossa iliaca dextra in front of the posterior part of the crista iliaca to the anterior surface of the m. quadratus lumborum dexter and then turns again somewhat forward to go over at the inferior pole of the right kidney through the flexura coli dextra into the colon transversum. Its right wall touches the lateral wall of the abdomen; its anterior wall in the contracted condition is completely, in the distended condition only partly, covered by loops of the small intestine and elsewhere is in contact with the anterior abdominal wall; its left wall is bounded partly by the m. psoas major, partly by loops of small intestine.

The *flexura coli dextra* (O. T. hepatic flexure of the colon) (see Figs. 642, 643 and 645) reaches either only from below to the inferior pole of the right kidney or covers the latter for some distance and is in contact in front and above with the impressio colica of the liver.



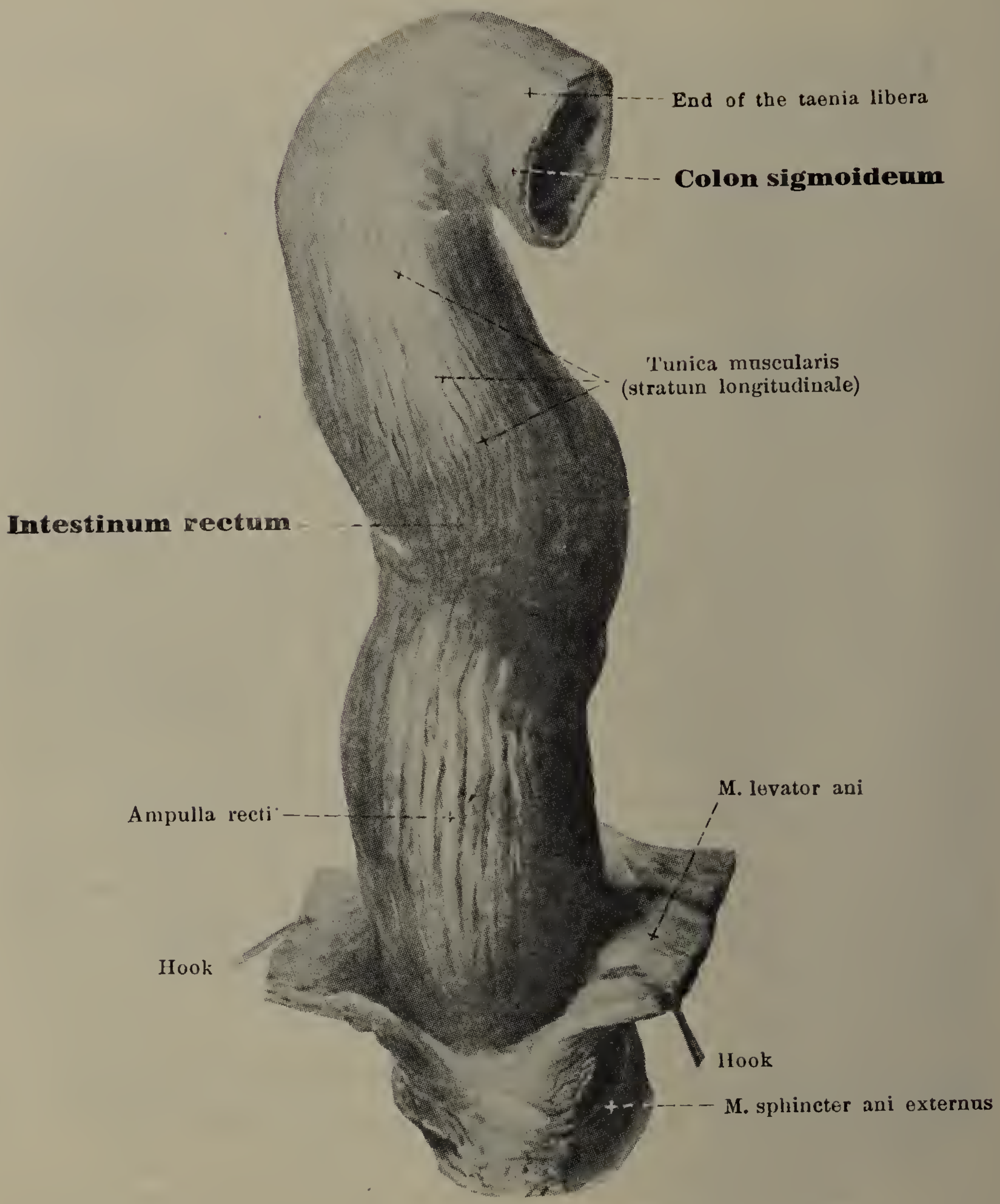
625. Valve of the large intestine *(valvula coli)*

and neighboring pieces of intestine, cut through, viewed from in front.

The ***colon transversum*** *(transverse colon)* (see Figs. 642 and 645) runs out to the left and somewhat upward from the flexura coli dextra over the median plane in a curve convex forward and at the same time somewhat downward and goes over just at the right of the extremitas inferior of the spleen through a sharp curve (flexura coli sinistra) into the colon descendens (see Fig. 644); it is often markedly curved downward. In its course it is bounded above by the impressio colica of the liver, the body of the gall bladder and the curvatura ventriculi major; it lies in front of the pars descendens duodeni, the pancreas, the pars ascendens duodeni and the upper part of the left kidney; on its inferior surface lie loops of the intestinum jejunum, the latter being on the left also shoved upward and partly behind it; its anterior surface (see Figs. 640 and 649) is covered by the omentum majus and by this separated from the anterior abdominal wall and (on the left) from the diaphragm.

The *flexura coli sinistra* (O. T. splenic flexure of the colon) makes a sharper bend than the flexura coli dextra and lies in front of the upper part of the lateral margin of the left kidney, regularly higher and farther dorsalward than the right; it reaches as far as the spleen (see p. 554) and may when the stomach is empty reach as far as the left dome of the diaphragm.

The ***colon descendens*** (see Figs. 641 and 642) runs, in a curve which is slightly convex backward and lateralward, to the inferior pole of the left kidney and then downward and forward on the lateral surface of the m. psoas major in front of the m. quadratus lumborum, the posterior part of the crista iliaca and the m. iliacus to the fossa iliaca sinistra; there it bends around and extends parallel to and above the lig. inguinale sinistrum to the right, downward and forward, in front of the m. iliopsoas until it is in front of the vasa iliaca externa and the left ductus deferens (in the male, the ligamentum teres uteri in the female); in that situation it goes over into the colon sigmoideum (see also Fig. 648). It is bounded above and on the left by the lateral wall of the abdomen; below, its anterior wall may lie partly against the anterior abdominal wall, otherwise it is overlapped by loops of small intestine (see Fig. 640). It is much longer than the colon ascendens.

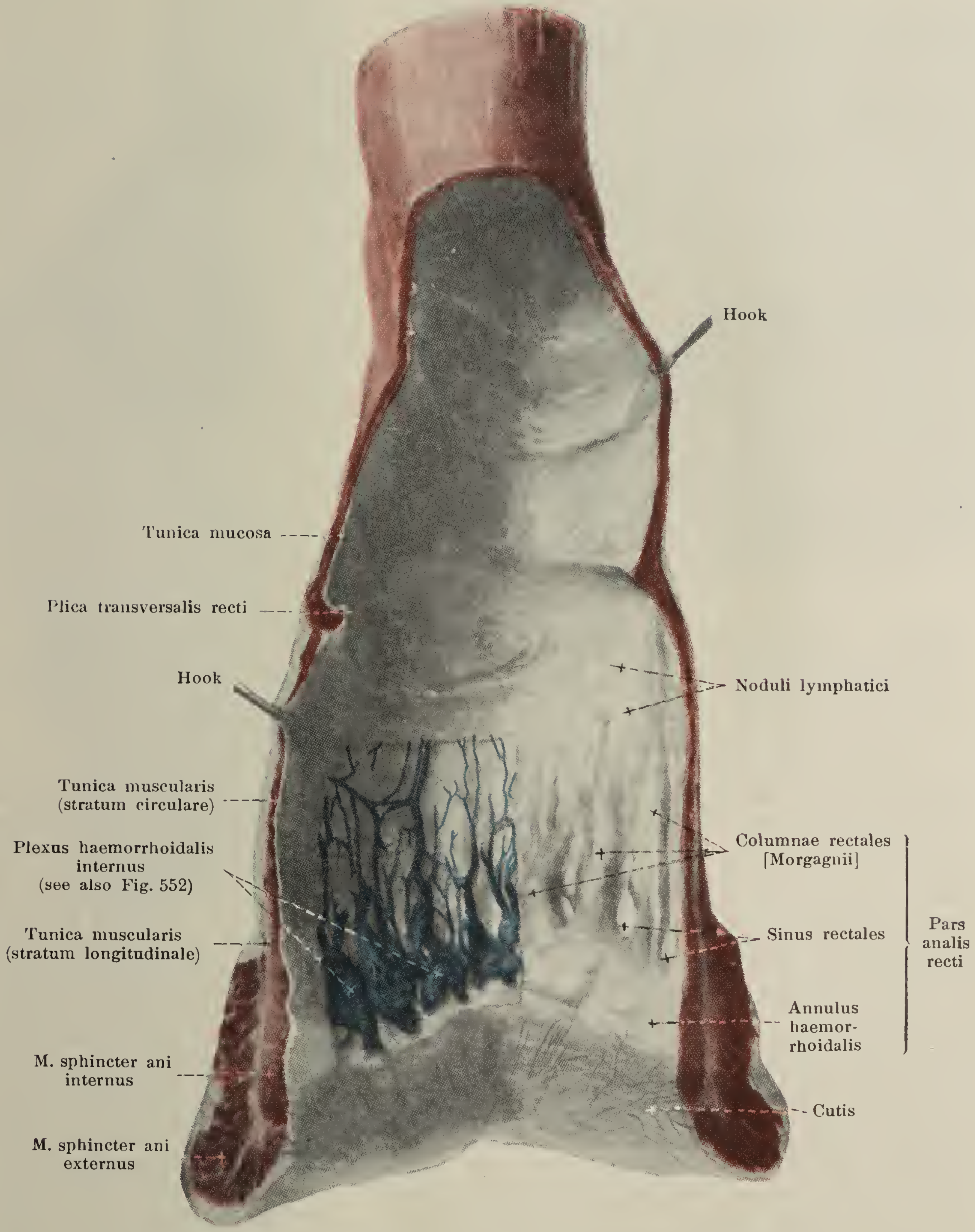


626. Rectum, after removal of the peritonaeum, viewed from in front.

The ***colon sigmoideum*** (O. T. sigmoid flexure of the colon) (see Figs. 642 and 648) forms between the colon descendens and the rectum a movable loop of variable length consisting of two limbs running nearly parallel to one another. This either hangs down into the small pelvis and lies upon the left and posterior wall of the same, or it passes directly upward or obliquely to the right and upward; the latter position is especially frequent in the new born. The colon sigmoideum is usually overlapped by loops of small intestine. At its termination it goes over, in a curve or straight, in front of the 3rd sacral vertebra in the median plane into the rectum. The junction is indistinct and only recognizable by the fact that the haustra which are indistinctly marked but still recognizable in the colon sigmoideum stop altogether, and that, of the three taeniae, the omentalis and the libera unite in order to form the anterior strengthening band of the longitudinal muscle of the rectum while the taenia mesocolica goes over into the posterior band.

Wall of the large or thick intestine.

The *tunica serosa (peritoneal coat),* after development has been completed, covers only the anterior, lateral and medial walls of the colon ascendens and descendens, the posterior wall being left free to a variable extent. The colon transversum is almost completely covered by it, being free from it only along the taenia mesocolica where the mesocolon transversum is attached, and along the taenia omentalis, where the omentum majus goes off. The colon sigmoideum behaves similarly to a loop of small intestine and there remains only a narrow strip uncovered by peritonaeum where the mesocolon sigmoideum is attached. Along the whole large intestine are found variably developed lobe-like fatty duplicatures of the tunica serosa, *appendices epiploicae;* they are usually situated near the taeniae (see Figs. 647 and 648).


Hook
Tunica mucosa
Plica transversalis recti
Hook
Noduli lymphatici
Tunica muscularis (stratum circulare)
Plexus haemorrhoidalis internus (see also Fig. 552)
Columnae rectales [Morgagnii]
Tunica muscularis (stratum longitudinale)
Sinus rectales
Pars analis recti
Annulus haemorrhoidalis
M. sphincter ani internus
Cutis
M. sphincter ani externus

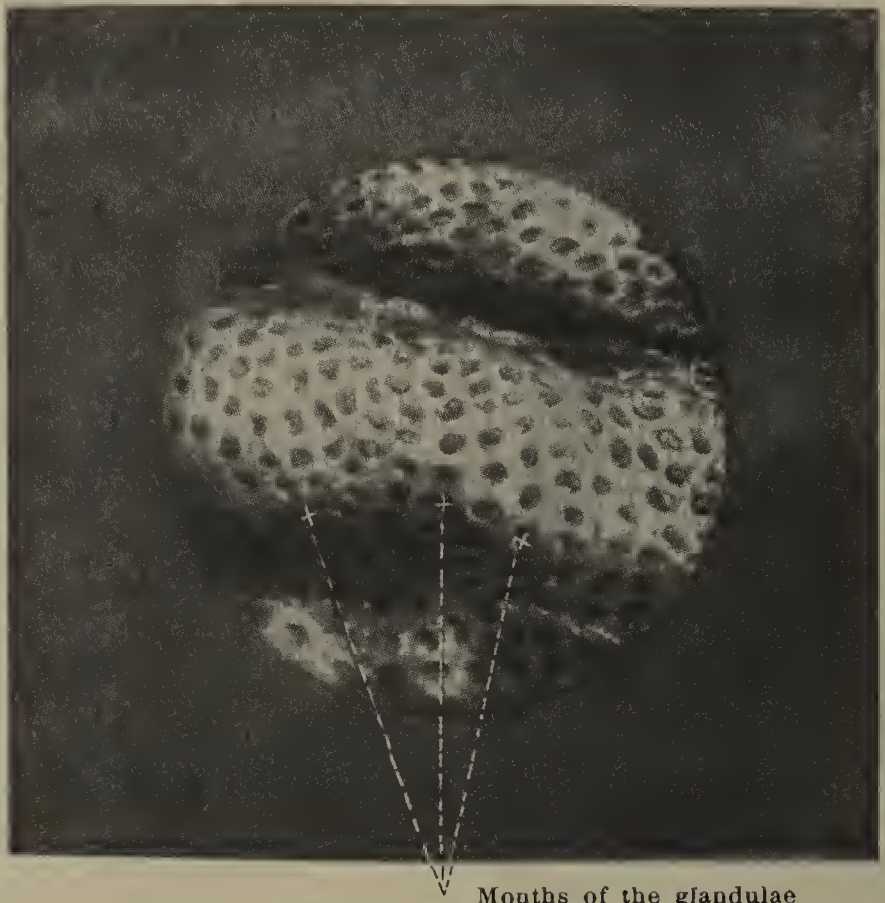
627. Rectum, opened, viewed from in front.

(A strip has been cut out of the anterior wall. The mucous membrane has been partly dissected off.)

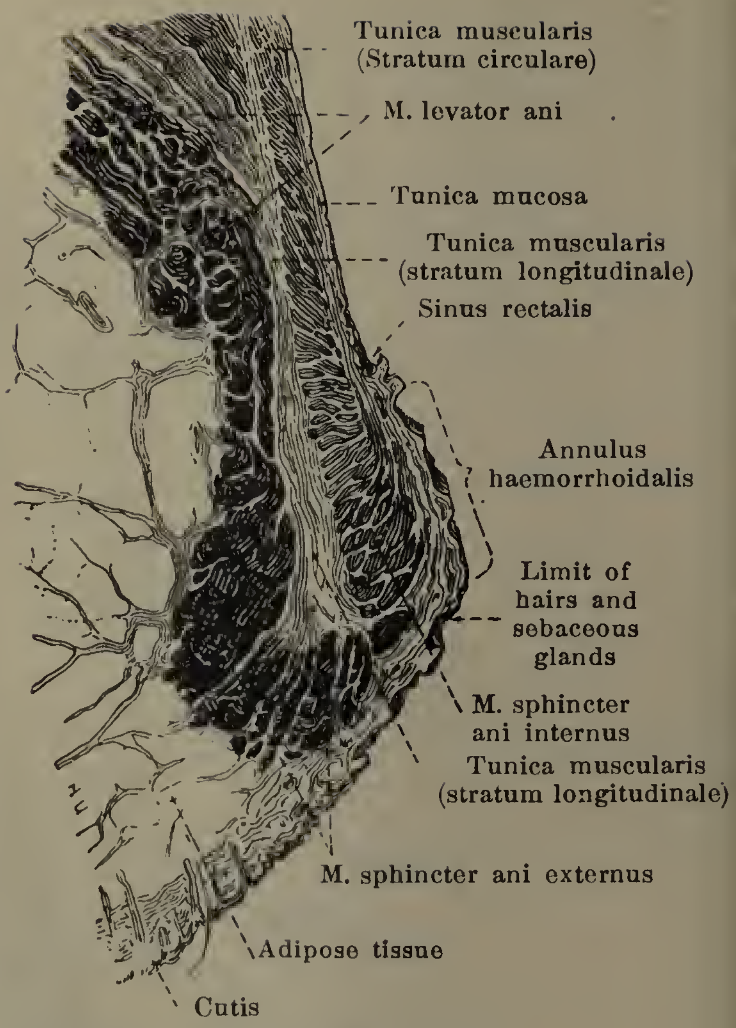
Wall of the large or thick intestine (continued):

Tunica muscularis: the *stratum longitudinale* is limited to three strips which are called the *taeniae coli* (see Figs. 622—624, 641 and 642). On the colon ascendens, colon descendens and colon sigmoideum the *taenia libera* is placed anteriorly, the *taenia mesocolica* posteriorly and medianward and the *taenia omentalis* posteriorly and lateralward; on the colon transversum the taenia libera lies below (see Figs. 641 and 646), the taenia mesocolica behind, the taenia omentalis in front and above. The *stratum circulare* is uninterrupted and is somewhat strengthened at the plicae sigmoideae. The thickness of the musculature increases somewhat from above downward.

The *tunica mucosa* is connected with the tunica muscularis by the connective tissue of the *tela submucosa* and is elevated into large sickle-shaped folds, *plicae semilunares coli* (see p. 539). Its finer structure agrees with that of the upper part of the rectum (see p. 547).



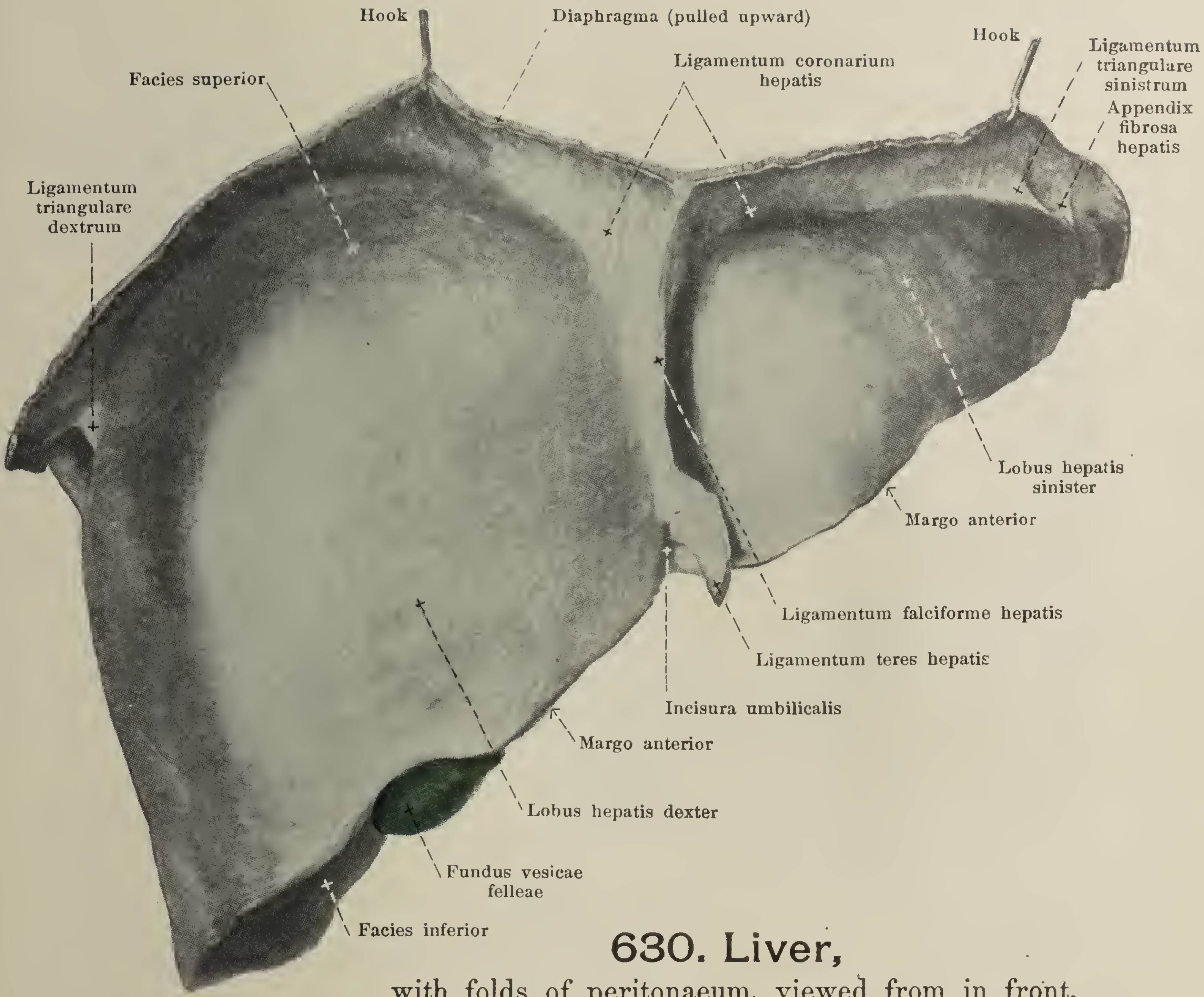
628. Mucous membrane of the rectum (upper part), viewed from the surface. Magnification: 12 : 1.


Tunica muscularis (Stratum circulare)
M. levator ani
Tunica mucosa
Tunica muscularis (stratum longitudinale)
Sinus rectalis
Annulus haemorrhoidalis
Limit of hairs and sebaceous glands
M. sphincter ani internus
Tunica muscularis (stratum longitudinale)
M. sphincter ani externus
Adipose tissue
Cutis

629. Transverse section through the pars analis recti. Magnification: 2 : 1.

The **rectum** *(intestinum rectum)* (see Figs. 626, 627, 642, 708, 709, 718 and 720) is the terminal portion of the digestive tube which extends from the colon sigmoideum through the inferior wall of the small pelvis to the inferior opening, the *anus*. It is about 16 cm long and runs in the median plane at first downward and backward, and extends forward and downward directly in front of the sacrum and coccyx in a curve which is concave forward and upward, the *flexura sacralis*, as far as the facies posterior of the prostata (in the male, the lower part of the posterior vaginal wall in the female); thence it goes downward and backward in a markedly curved arch convex in front, the *flexura perinealis*. It is covered above in front and laterally by peritonaeum; the lines of reflection of the peritonaeum then gradually turn forward and leave the lateral walls uncovered. From the anterior wall in the region of the right plica transversalis recti (see p. 547), the peritonaeum in the male is reflected upon the bladder at the level of the mouths of the ureters and thus lines a fossa, the *excavatio rectovesicalis* (see p. 615); in the female it turns to the posterior wall of the vagina at the level of the orificium externum uteri and forms the *excavatio rectouterina [cavum Douglasi]* (see p. 623). In this portion of its course the rectum is covered above by loops of small intestine or by the colon sigmoideum; below, its anterior wall lies in the male on the posterior surface of the bladder when the latter is distended, in the female on the uterus. Beneath the site of reflection of the peritonaeum the anterior wall in the male lies against the fundus vesicae, the ductus deferentes and vesiculae seminales as well as the facies posterior prostatae, in the female against the posterior wall of the vagina. The rectum then turns away from these structures backward and downward, and is surrounded a little above the anus by the fibres of the mm. levatores ani and sphincter ani externus. In the frontal direction also it often presents curves, produced by lateral furrows, which correspond to the plicae transversales recti (see p. 547). The middle portion is rarely entirely empty; it is often on the contrary the site of a spindle-shaped distention, the *ampulla recti*. The lowest portion surrounded by the mm. levatores ani and the mm. sphincteres, corresponding to the pars analis recti (see p. 547) is always found empty and contracted, and represents the *canalis analis* the narrow, the slit-like lumen of which lies in the median plane.

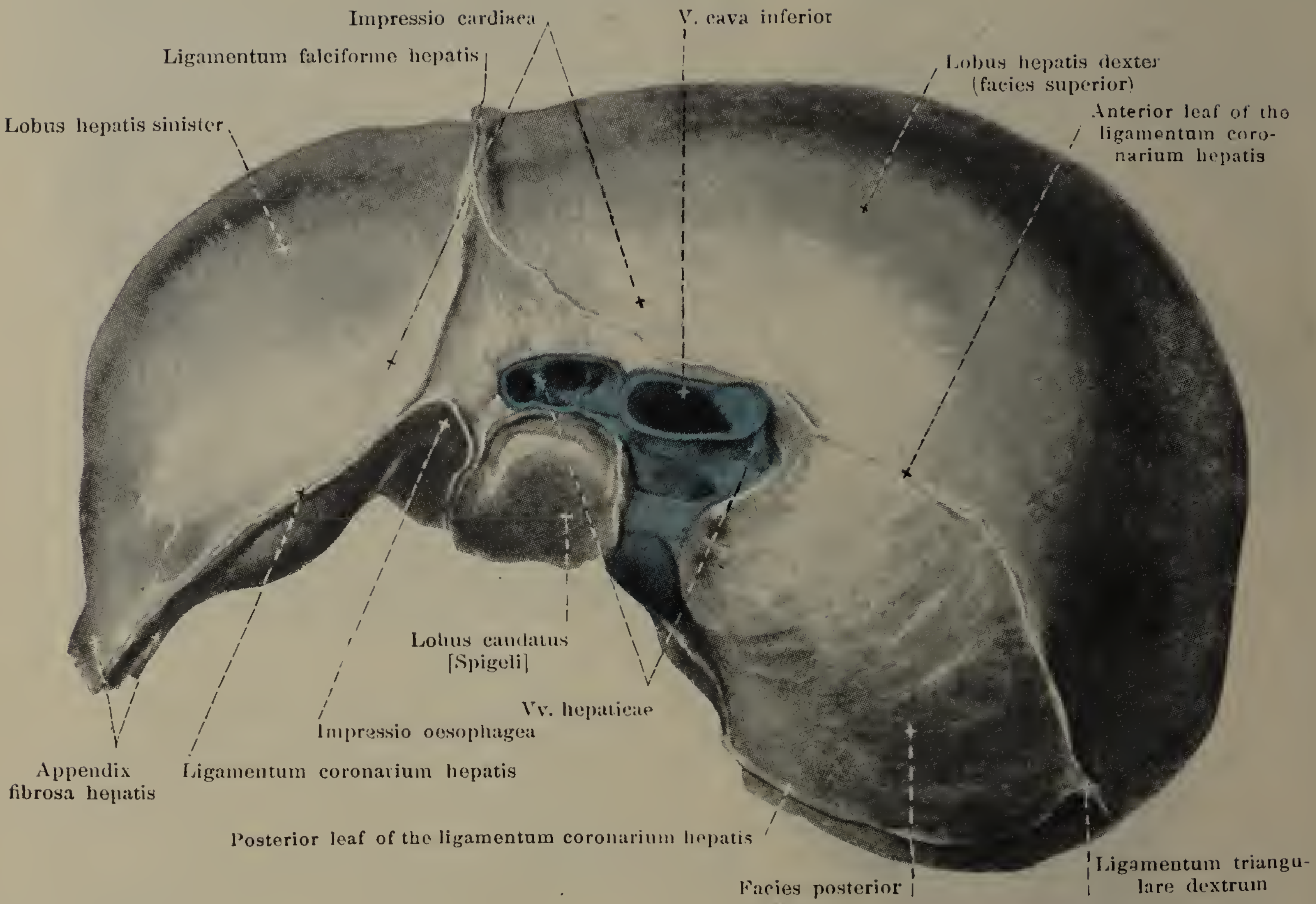
Wall of the rectum. Tunica muscularis (see also Fig. 626). The *stratum longitudinale* covers the whole surface but forms in front and behind a stronger and shorter band of fibres (see p. 544); only in the lower part of the ampulla is the distribution more even. A band of smooth muscle fibres which arise from the lig. sacrococcygeum anterius, *m. rectococcygeus* (see Figs. 723 to 725) is mixed with them on the posterior surface. The longitudinal fibres interweave below with the fibres of the mm. levatores ani and go partly to the skin. The *stratum circulare* is emphasized in the base of each plica transversalis; at the inferior end it is concentrated gradually to form the *m. sphincter ani internus* and reaches as far as the junction with the external skin.



630. Liver,

with folds of peritonaeum, viewed from in front.

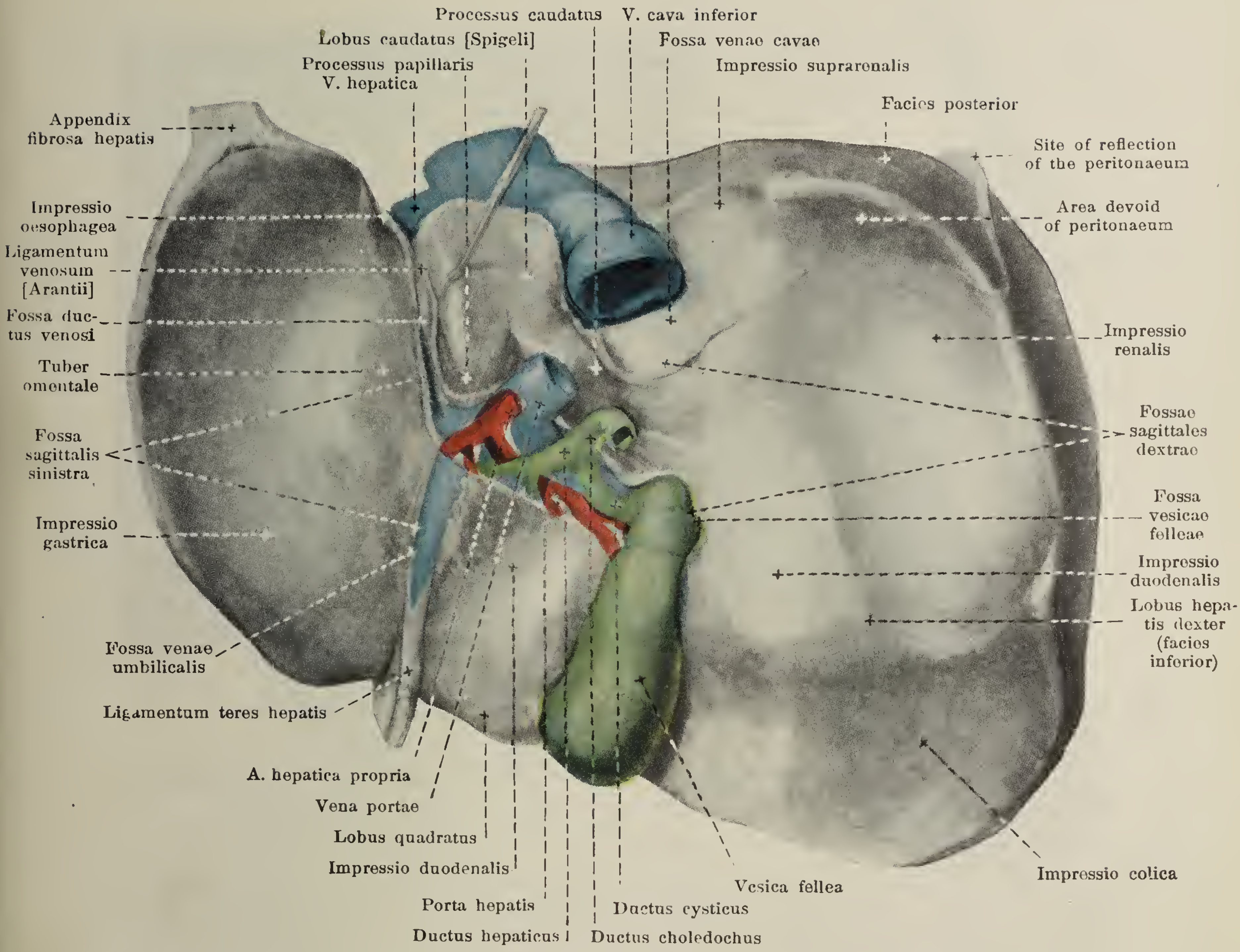
Wall of the rectum (continued). The *tunica mucosa (mucous membrane)* (see Figs. 627 and 628) is separated from the tunica muscularis by the connective tissue of the *tela submucosa.* It forms in the distended rectum in common with this (and a band of the circular muscle layer) usually two sickle-shaped transverse folds, *plicae transversales recti*, which surround more than half the circumference of the tube; of these two folds the lower, larger one, 6—6,5 cm above the anus, lies on the right (see Figs. 709 and 719), the upper one 9—10 cm above the anus on the left; a third is often present on the left below them about 4 cm above the anus. Below the ampulla recti project 5—10 longitudinal folds of the mucous membrane, *colomnae rectales [Morgagnii]*, which contain bundles of longitudinal muscles. They become higher and broader below and each unites with the two neighboring ones by means of arch-like folds which help to bound fossa-like depressions open above, the *sinus rectales.* The next zone, *annulus haemorrhoidalis*, reaches below as far as the line from which on hairs, sebaceous glands and glandulae circumanales appear; it bounds the *anus*, is fairly smooth when distended, but at other times presents a circular ridge due to the bulging of the m. sphincter ani internus and indentations corresponding to radial folds streaming out to the skin (see Fig. 722). At the mucous membrane of the annulus haemorrhoidalis and somewhat above it can often be seen ampulla-like dilatations of the venous plexus haemorrhoidalis internus which may develop into flask-shaped projections, *haemorrhoidal tumors (varices haemorrhoidales).* The region of the columnae rectales, the sinus rectales and the annulus haemorrhoidalis is as whole designated the *pars analis recti.* The mucous membrane in the upper part has the same structure as in the large intestine; it is whitish, contains numerous tube-like *glandulae intestinales [Lieberkuehni]* running perpendicularly to the surface, the openings of which are visible as small holes with the aid of a hand-lens (see Fig. 628) and between them are scattered lymph nodules, *noduli lymphatici*, the domes of which project somewhat above the surface (see Fig. 627). The mucous membrane of the annulus haemorrhoidalis changes somewhat in structure and mediates the gradual transition to the external skin.


Impressio cardiaca
V. cava inferior
Ligamentum falciforme hepatis
Lobus hepatis dexter (facies superior)
Anterior leaf of the ligamentum coronarium hepatis
Lobus hepatis sinister
Lobus caudatus [Spigeli]
Vv. hepaticae
Impressio oesophagea
Appendix fibrosa hepatis
Ligamentum coronarium hepatis
Posterior leaf of the ligamentum coronarium hepatis
Facies posterior
Ligamentum triangulare dextrum

631. Liver

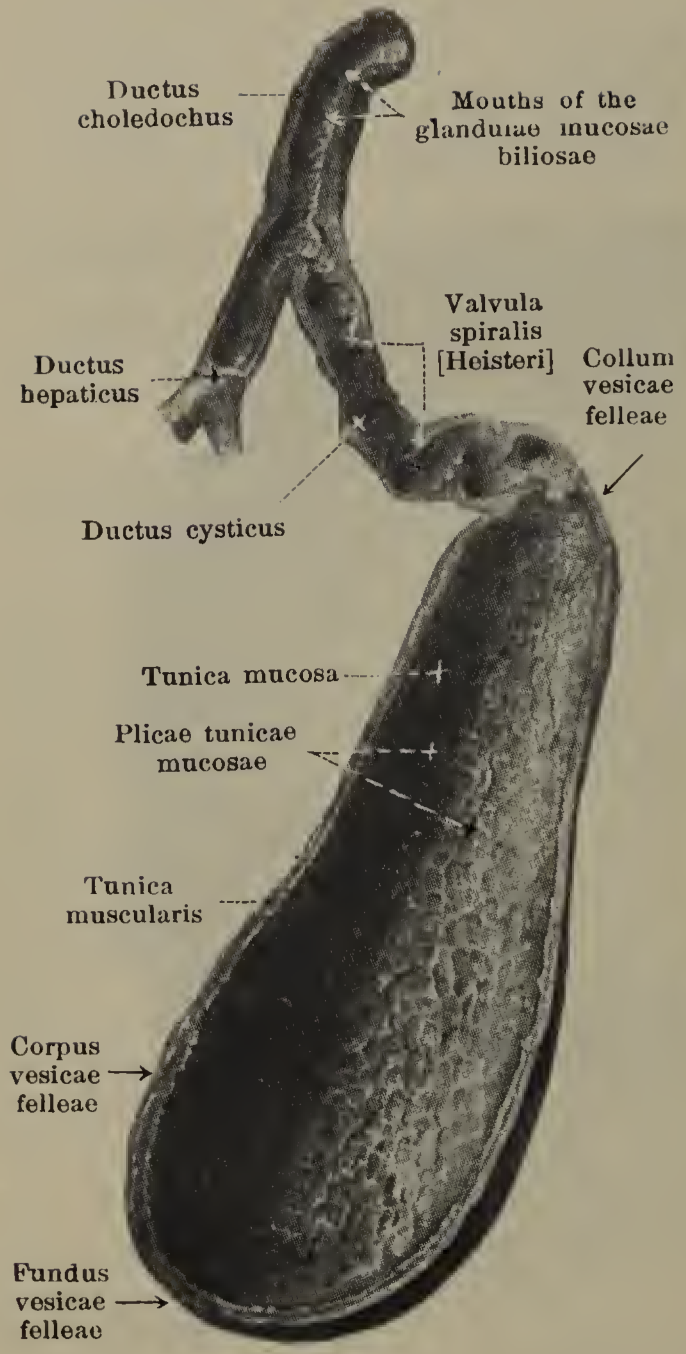
with lines of reflection of the peritonaeum, viewed from above.

The **liver** *(hepar)* (see also Figs. 630 and 632) is a large, reddish-brown gland, almost 2 kilo in weight, approximately wedge-shaped, which is situated for the most part to the right of the median plane in the regio hypochondriaca dextra and in the regio epigastrica, a small part however reaching over into the regio hypochondriaca sinistra. It presents for examination five surfaces, a right, an anterior and a superior which together form the *facies superior*, a posterior, *facies posterior*, and an inferior, *facies inferior*. The facies superior and inferior meet in the sharpened *margo anterior;* on the right side this presents a shallow indentation, in which the fundus of the gall bladder is visible, on the left side a sharper notch, the *incisura umbilicalis*. This notch and a fold of peritonaeum running upward from it on the facies superior separate a larger, right lobe, *lobus hepatis dexter*, from a smaller, left, variable *lobus hepatis sinister*. On the inferior and posterior surfaces, the left lobe is bounded by the correspondingly directed *fossa sagittalis sinistra*, while a medial region is marked off from the right lobe by the *fossae sagittales dextrae*, approximately parallel to it; this medial region is divided by the transversely placed *porta hepatis* into the *lobus quadratus* and the *lobus caudatus [Spigeli]*. The *right surface* is approximately rectangular and everywhere somewhat convex; it goes over gradually into the anterior, superior and posterior surfaces; with the inferior it helps to form the margo anterior. The *anterior surface* is approximately triangular and smooth; it is not sharply limitable from the superior surface and with the inferior surface it forms the margo anterior. The *superior surface*, like the right and (for the most part) the anterior, lies directly against the diaphragm and is curved corresponding to the shape of that structure; it reaches somewhat higher up on the right than on the left and between is slightly depressed *(impressio cardiaca);* it meets the posterior surface in a blunt margin. The *facies posterior* is approximately rectangular-triangular, and is uneven. It is curved so as to be convex on the right side where it is formed by the right lobe of the liver; passing to the left there then follows the superior fossa sagittalis dextra as a flat furrow, *fossa venae cavae*, which is filled up by the v. cava inferior; it helps to bound below the triangular fossa situated to the right, namely the *impressio suprarenalis*, for the glandula suprarenalis dextra.

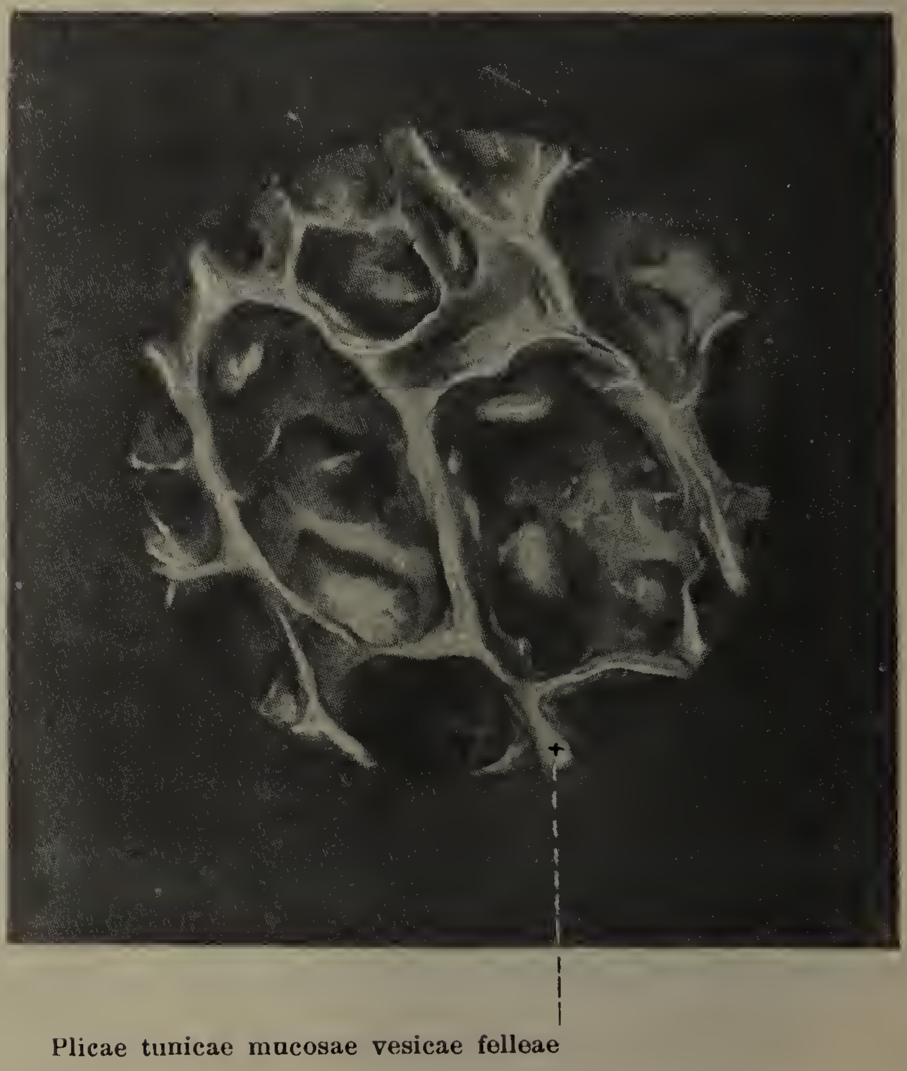


632. Liver with lines of reflection of the peritonaeum, from below and behind.

Liver (continued). To the *facies posterior* belongs farther the quadrangular, oblong lobus caudatus, the long axis of which is placed vertically and lies upon the right crus mediale diaphragmatis. To the left of this follows the upper part of the fossa sagittalis sinistra, the *fossa ductus venosi*, which extends for a variable distance in front of the lobus caudatus and in its depth contains the cord-like *ligamentum venosum [Arantii]*, the obliterated ductus venosus (see p. 491). Near the upper part of this fossa, on the left lobe of the liver, the groove-like *impressio oesophagea* (for the pars abdominalis oesophagi) runs downward and to the left. The *facies inferior* is very irregular and runs obliquely forward, downward and to the right; it is bounded behind on the right at the posterior surface by a blunt margin, on the left at the upper by a sharper margin, the continuation of the margo anterior. The right lobe presents in front a flat depression, *impressio colica*, for the flexura coli dextra and the colon transversum; behind it on the right lies the oblong *impressio renalis* for the right kidney and to the left of it the flatter *impressio duodenalis* for the pars descendens duodeni. Thence, in front of the fossa venae cavae and behind the fossa vesicae felleae, a strip of liver substance, the *processus caudatus*, extends to the left to the inferior margin of the lobus caudatus; to the left of it projects downward a flat process of the latter, the *processus papillaris*. Directly in front of these structures lies the porta hepatis and in front of it the lobus quadratus, which is slightly concave for the pars superior duodeni, *impressio duodenalis*, and the pars pylorica of the stomach. On the right this lobe is bounded by the flat inferior fossa sagittalis dextra, the *fossa vesicae felleae*, which is completely hidden by the gall bladder, on the left by the inferior part of the fossa sagittalis sinistra, the narrow *fossa venae umbilicalis*, in which is situated the cord-like *ligamentum teres hepatis*, the obliterated v. umbilicalis (see p. 491). On the left lobe of the liver near the processus papillaris can be seen a larger projection, the *tuber omentale*, which adjoins the omentum minus; it is surrounded by a deep and broad groove, *impressio gastrica*, in which the stomach comes into contact with the liver.



633. Gall bladder and bile ducts,
cut through.



634. Mucous membrane of the gall bladder,
viewed from the surface. Magnific.: 14 : 1.

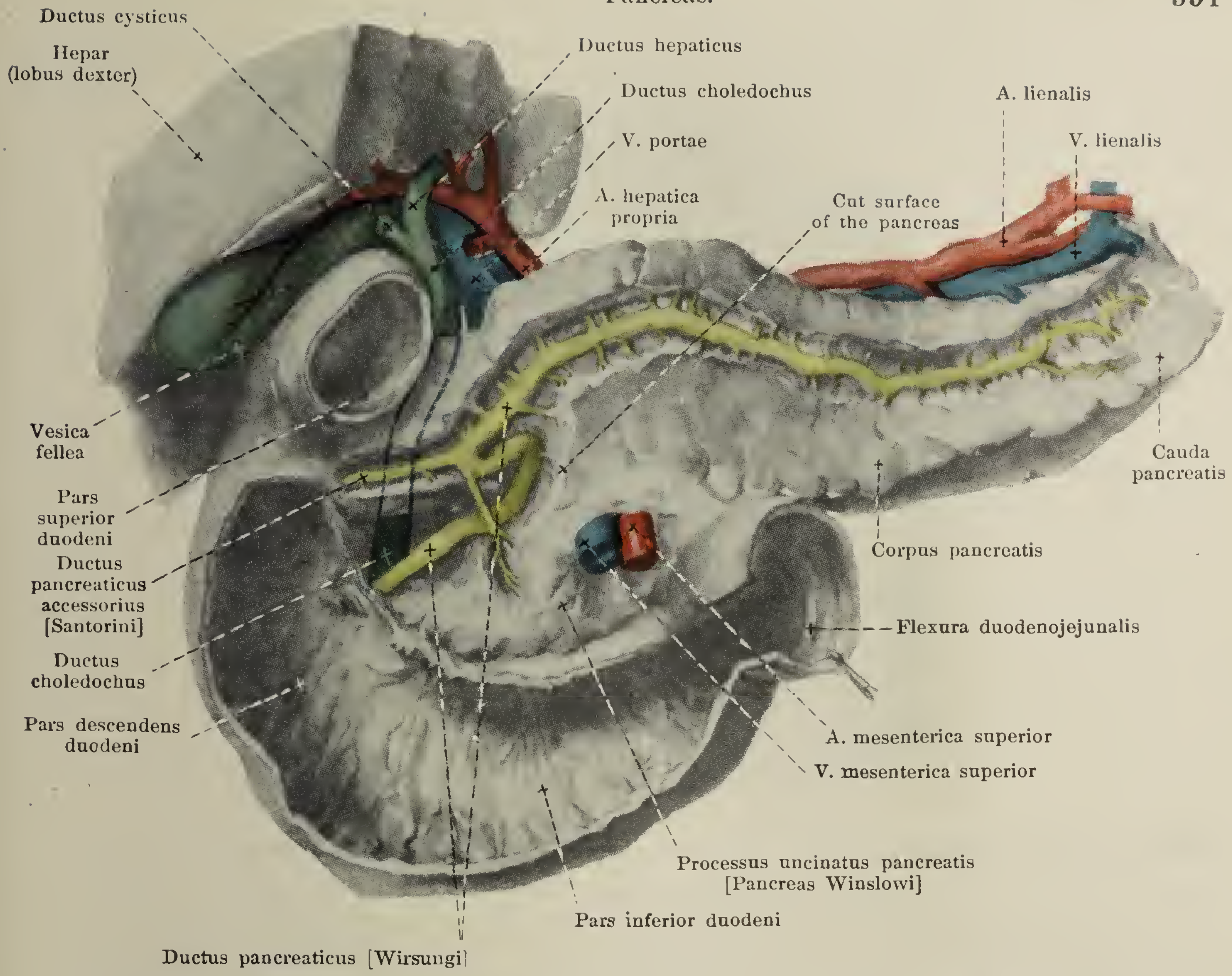
Liver (continued) (see Figs. 630—632). The posterior part of the sharpened edge of the left lobe not infrequently presents a flat appendix of variable size, composed of connective tissue, the *appendix fibrosa hepatis;* it is the remnant of the liver substance present there in the new-born and later still contains parts of the bile ducts, the *vasa aberrantia hepatis* (not illustrated), and blood vessels.

The liver completely fills up the dome of the diaphragm on the right side, only partly on the left, and is in contact with this muscle in the largest part of the facies superior and posterior. It is covered to a large extent by the lower ribs; its anterior surface lies directly in contact with the anterior abdominal wall (see Fig. 642) only in the regio epigastrica above a line which extends between the anterior ends of the right 9th or 10th and the left 8th costal cartilage; the incisura umbilicalis is situated somewhat to the right of the median plane. The facies inferior is in close contact with various abdominal organs all of which leave impressions upon it (see these, p. 549). Beneath the processus caudatus is situated the foramen epiploicum [Winslowi].

The liver is for the most part covered by the *tunica serosa (peritoneal coat).* Only the posterior surface of the right lobe, a triangular field on the upper surface in front of the lobus caudatus, the porta hepatis, the fossae sagittales and two additional narrow strips remain free from it; of the latter one extends from the incisura umbilicalis upward to the triangular area mentioned and is situated at the starting point of the ligamentum falciforme hepatis, while the other runs from the triangular area to the left as far as the appendix fibrosa, and serves as an origin for the left portion of the ligamentum coronarium hepatis and the ligamentum triangulare sinistrum. From the fossa ductus venosi and the porta hepatis the omentum minus goes off.

At the porta hepatis the branches of the v. portae and the a. hepatica enter the liver and the branches of the ductus hepaticus leave it, while the vv. hepaticae leave the liver on the upper surface in the neighborhood of the fossa venae cavae.

A sagittal plane passing through the v. cava inferior and the fundus of the gall bladder divides the liver into two parts of almost equal weight and separates fairly exactly the domains of the right and left branches of the v. portae, of the a. hepatica and of the ductus hepaticus.



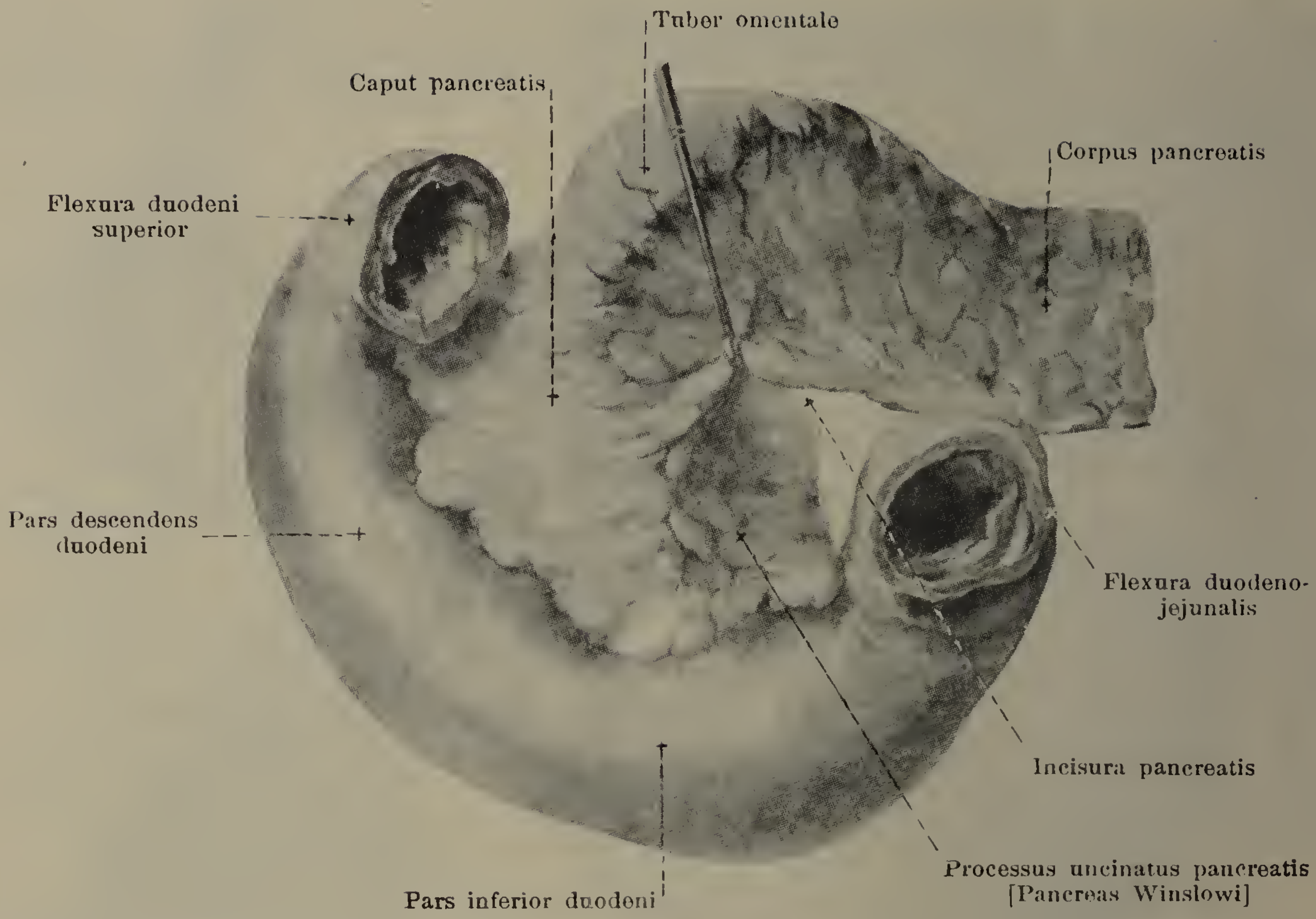
635. Excretory ducts of the liver and pancreas,
viewed from in front.

(In the pancreas the ducts have been dissected out; the duodenum has been partly opened; of the liver only the right lobe has been retained and it has been pressed somewhat aside.)

The *ductus hepaticus* (see also Figs. 632 and 633), the excretory duct of the liver, begins in the porta hepatis by the union of a right and a left branch. It runs downward in the ligamentum hepatoduodenale to the right of the a. hepatica propria and in front of the v. portae and soon unites at an acute angle with the ductus cysticus to form the ductus choledochus (vide infra).

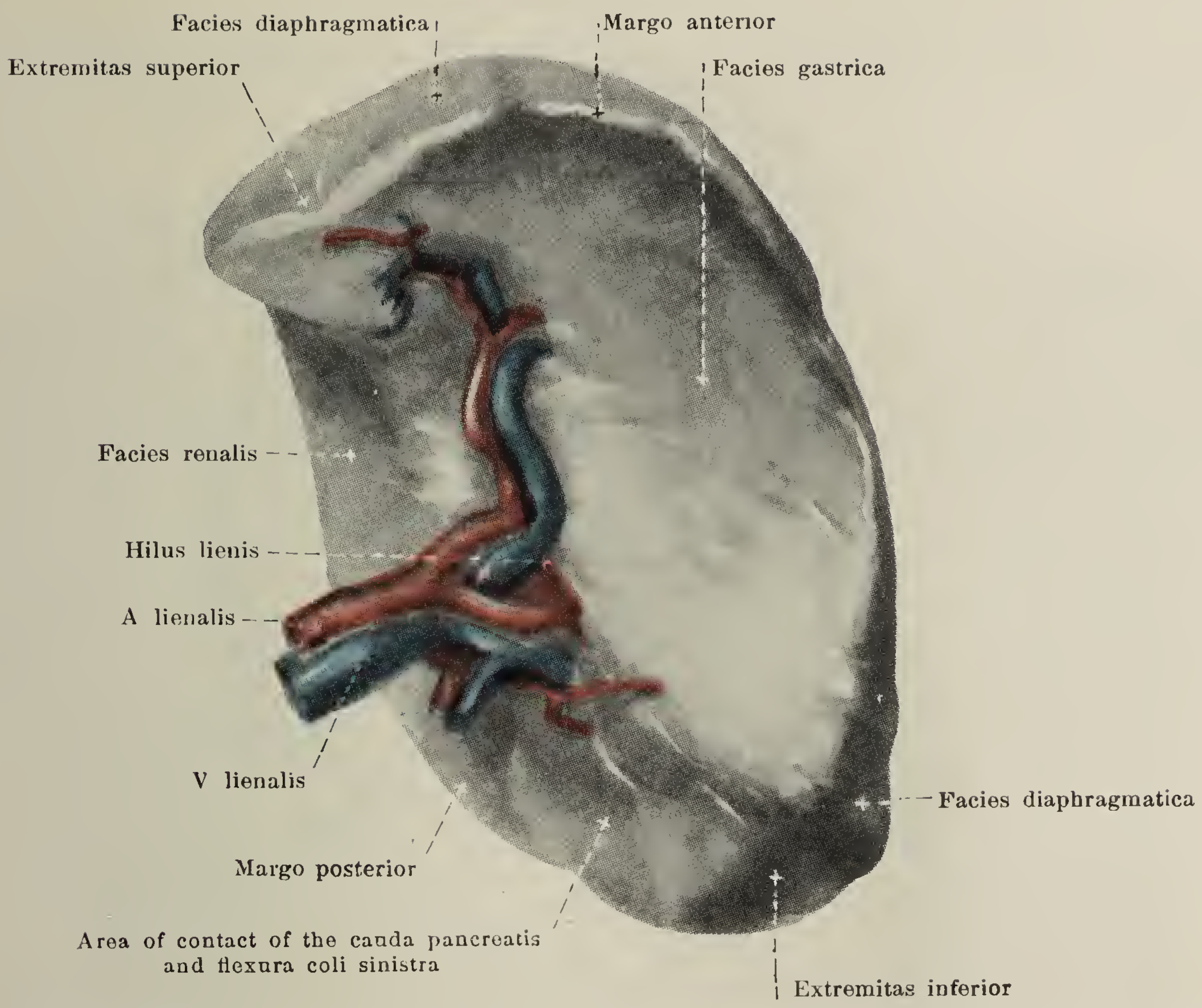
The ***gall bladder*** *(vesica fellea)* (see also Figs. 632—634, 642—645) is an oblong, pear-shaped sac, which is fastened by loose connective tissue in the fossa vesicae felleae of the liver. When the bladder is full, its broad, blind and rounded end, *fundus vesicae felleae*, projects somewhat beyond the margo anterior of the liver and comes in contact with the anterior abdominal wall just medianward from the anterior extremity of the 9th costal cartilage of the right side. From the fundus the *corpus vesicae felleae* extends upward, backward and somewhat to the left and narrowing suddenly *(collum vesicae felleae)* goes over at the right side of the porta hepatis into the ductus cysticus. The gall bladder comes into contact below with the colon transversum and behind with the pars descendens duodeni. The fundus and the posterior, inferior surface possess a peritoneal coat, *tunica serosa.* The wall consists of a delicate layer of mostly circular muscle fibres, *tunica muscularis,* and a mucous membrane, *tunica mucosa*, from which project numerous ridges, *plicae tunicae mucosae,* arranged in the form of a network. The *ductus cysticus* leaves the bladder with a marked downward bend, extends downward and to the left and after a short course joins the ductus hepaticus; its mucous membrane presents a series of folds, which are arranged in the form of a spiral *(valvula spiralis [Heisteri])*, and which correspond to grooves on the external surface.

The *ductus choledochus* runs downward, in the direction of the ductus hepaticus, at first in the ligamentum hepatoduodenale to the right of the v. portae, then in the caput pancreatis at the junction of the left and posterior walls of the pars descendens duodeni. It perforates the tunica muscularis of the same, extends downward in the tela submucosa and opens near the ductus pancreaticus or in common with it at the inferior extremity of the plica longitudinalis duodeni.



636. Pancreas, right portion, drawn apart, viewed from in front.
(The peritonaeum has been dissected off.)

The **pancreas** (see also Figs. 614 and 635) is an unpaired, long gland of a grayish-red color which lies transversely in front of the posterior wall of the abdominal cavity. It presents for examination a *caput*, a *corpus* and a *cauda pancreatis.* The *caput pancreatis* fills up the concavity of the pars descendens and pars inferior duodeni and is intimately united with their walls. A notch directed from left to right, *incisura pancreatis,* in which run the a. and v. mesenterica superior, marks off the inferior portion, *processus uncinatus [Winslowi];* this lies below upon the pars inferior duodeni; above it is shoved up behind the upper portion and is hollowed out in the form of a groove on its anterior surface for the a. and v. mesenterica superior. From its upper part and from the beginning of the corpus a broad, blunt-wedge-shaped mass, the *tuber omentale,* projects forward and upward, its dome covered by peritonaeum coming into contact with the inferior surface of the omentum minus. The anterior surface, *facies anterior,* of the caput, is in contact above with a part of the corpus ventriculi, with the pars pylorica of the stomach and with the pars superior duodeni, below with loops of small intestine; between the two it is crossed by the colon transversum. The posterior surface *(facies posterior)* of the caput is curved so as to be concave from right to left and is in close contact in front of the 1st and 2nd lumbar vertebra with the pars lumbalis diaphragmatis, the aorta abdominalis and the v. cava inferior; above it is in contact with the a. coeliaca, a. and v. mesenterica superior and the beginning of the v. portae as well as the vena lienalis and the v. renalis sinistra, on the right with the ductus choledochus. The *corpus pancreatis (body of the pancreas)* is curved from right to left so as to be somewhat convex behind and has an approximately triangular prismatic shape. Its *facies anterior* is directed forward and upward and curved so as to be concave, corresponding to the bulging curvature of the paries posterior ventriculi, which is in contact with it. The *facies inferior* is narrower and curved slightly in the form of the letter S. It rests to the right upon the flexura duodenojejunalis, to the left upon the end of the colon transversum; between lie upon it the loops of the upper part of the small intestine. With the anterior surface it forms a sharp margin, *margo anterior,* directed toward the root of the mesocolon transversum. The *facies posterior* is in direct contact with the v. lienalis and the v. renalis sinistra, the left suprarenal and kidney and presents a flat depression corresponding to these organs, as well as a groove for the left renal vessels and the v. mesenterica inferior. With the inferior surface it forms the blunter *margo posterior,* with the anterior surface the sharper *margo superior,* which is concave upward. The *cauda pancreatis (tail of the pancreas)* is the blunt end directed to the left and upward; its narrow inferior surface lies upon the flexura coli sinistra and its posterior surface comes into contact with the lower part of the spleen.

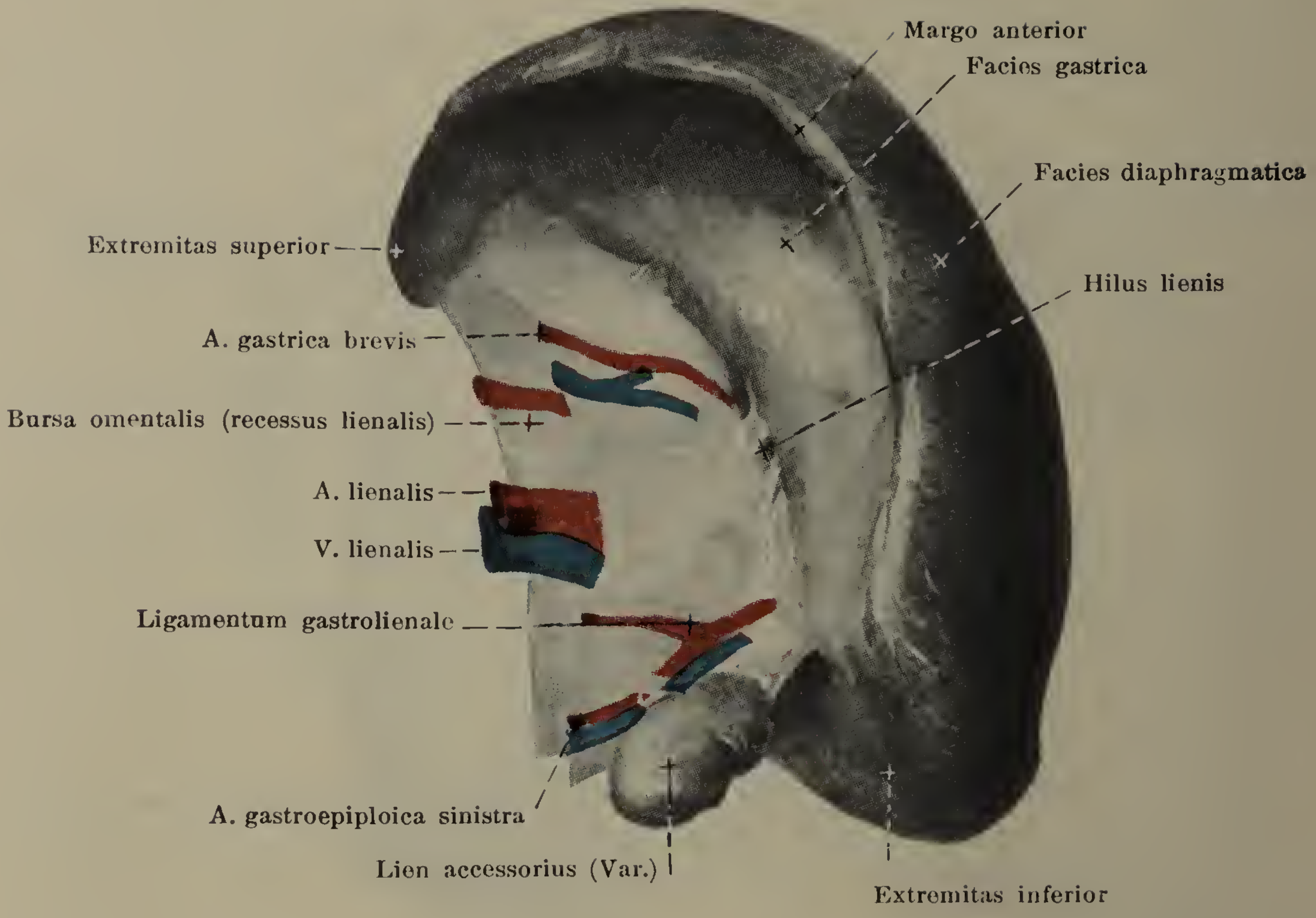


637. Spleen, viewed from in front and somewhat from the right.
(The peritonaeum has been dissected off at the hilus lienis.)

Pancreas (continued): The anterior and inferior surfaces are covered by peritonaeum (see Fig. 614). The posterior surface is free from it (see also p. 567); in addition, transversely in front of the caput and along the margo anterior, is a narrow strip which remains uncovered by peritonaeum and to which is turned the root of the mesocolon transversum. The portion lying above this strip belongs to the bursa omentalis. On the portion situated below this strip there is also free from peritonaeum the area, in which the a. and v. mesenterica superior extend to the root of the mesentery.

The *duct (ductus pancreaticus [Wirsungi])* (see Fig. 635) begins as a delicate duct in the cauda, extends within the substance of the gland to the right to the caput and gradually enlarges as it receives numerous narrow branches. In the caput it is markedly tortuous and runs to the right and somewhat downward; near its lower end it lies close to the ductus choledochus and opens at the inferior extremity of the plica longitudinalis duodeni (see also Fig. 615) either after previous union with the former or separately from it. In the upper part of the caput, in front of the ductus choledochus, very often runs in a transversal direction a small duct *(ductus pancreaticus accessorius [Santorini]),* which opens as well in the main duct as in the duodenum (upon the papilla duodeni [Santorini] see also Fig. 615), and which generally a little decreases in its diameter from the left to the right; sometimes the opening in the duodenum is absent; sometimes the upper duct is the larger of the two or opens in common with the ductus choledochus.

The **spleen** *(lien)* (see also Fig. 638) is an unpaired, soft, oblong organ, very variable in size, of a dark bluish-red color. Its largest surface, *facies diaphragmatica,* directed to the left, backward and upward, is smooth and convex. It is separated by a blunt margin, *margo posterior,* from the narrow, flat or slightly concave *facies renalis,* which is directed medianward and downward. The sharper, repeatedly indented *margo anterior* separates the facies diaphragmatica from the markedly concave *facies gastrica,* which looks forward and to the right. Upon this, near the medial margin and parallel with it, lies a series of depressions or a slit, the *hilus lienis,* in which enter or leave the vessels and nerves. The upper pole of the spleen, *extremitas superior,* is curved medianward; the lower pole, *extremitas inferior,* is directed to the left and downward. The medial surface of the latter goes over usually into an approximately triangular area, well marked off from the facies renalis and gastrica; this area serves above (in the immediate neighborhood of the hilus) for contact with the cauda pancreatis and below for contact with the flexura coli sinistra.



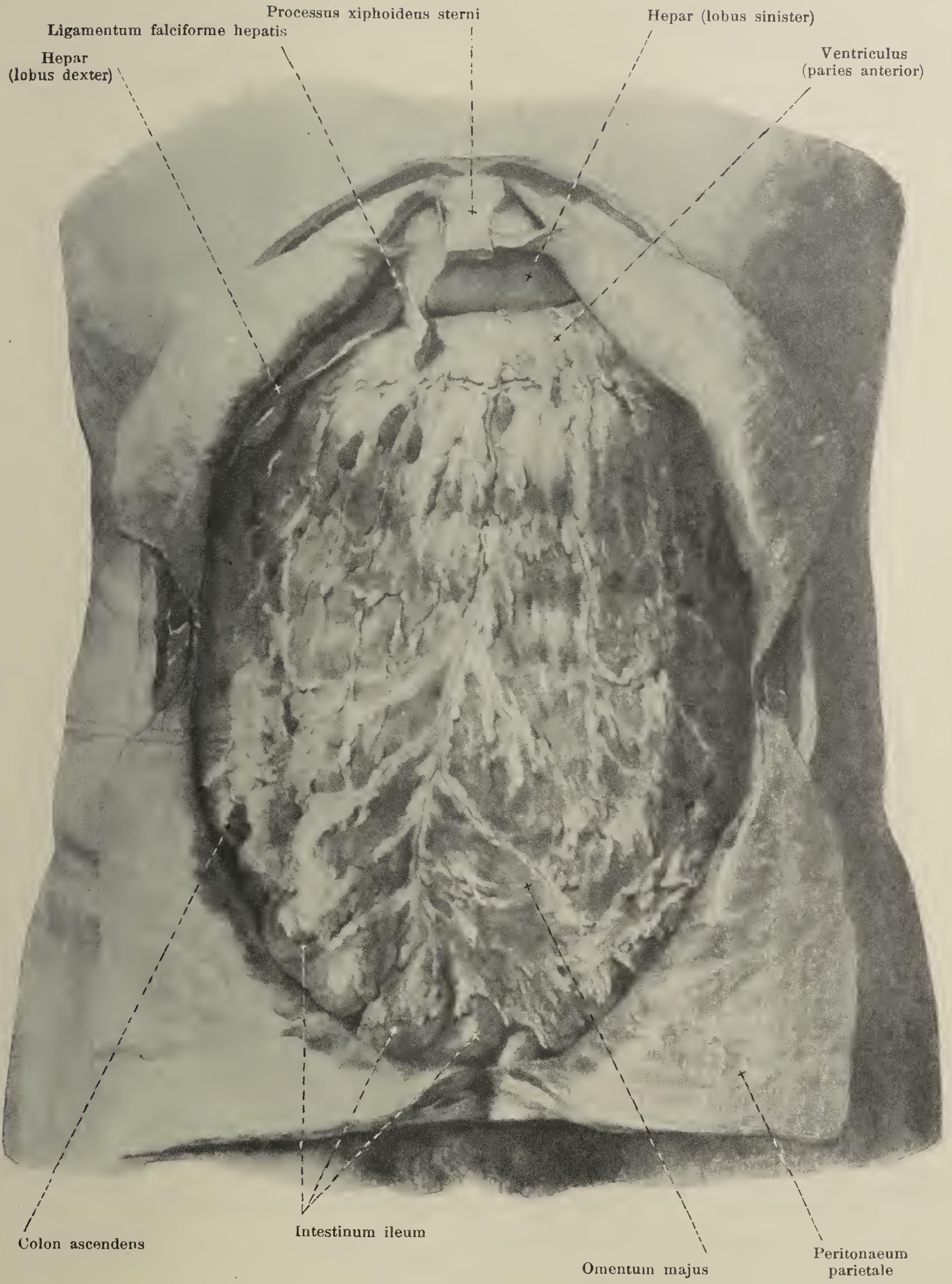
638. Spleen with peritonaeum,

viewed from in front and somewhat from the right.

Spleen (continued): *Position* (see Figs. 643 and 644). It lies in the posterior part of the left regio hypochondriaca so inserted between the posterior circumference of the stomach, left kidney and diaphragm that it is not visible from in front. Its facies diaphragmatica is so closely in contact with the concave surface of the diaphragm that it corresponds approximately to the space between the 9th and 11th rib on the left side, and that its long diameter runs approximately parallel to the 10th rib; it is separated from the ribs not only by the peritonaeum and diaphragma but partly also by the pleural cavity and the lung. The extremitas superior reaches close to the left side of the body of the 10th or 11th thoracic vertebra. The facies renalis is in contact with the margo superior of the left suprarenal gland and with the upper anterior part of the margo lateralis of the left kidney. The facies gastrica is bounded in front and to the right by the fundus and corpus ventriculi; the triangular area beneath it lies in contact with the cauda pancreatis and the flexura coli sinistra. Near the latter is situated also the extremitas inferior; it rests in a pocket *(saccus lienalis, spleen bed)* which is bounded in front by the *ligamentum phrenicocolicum* (O. T. sustentaculum lienis) (see Fig. 644). This stretches out membrane-like from the flexura coli sinistra to the region of the origin of the diaphragm from the 10th or 11th rib and presents a free margin directed upward; originally it is connected with the great omentum.

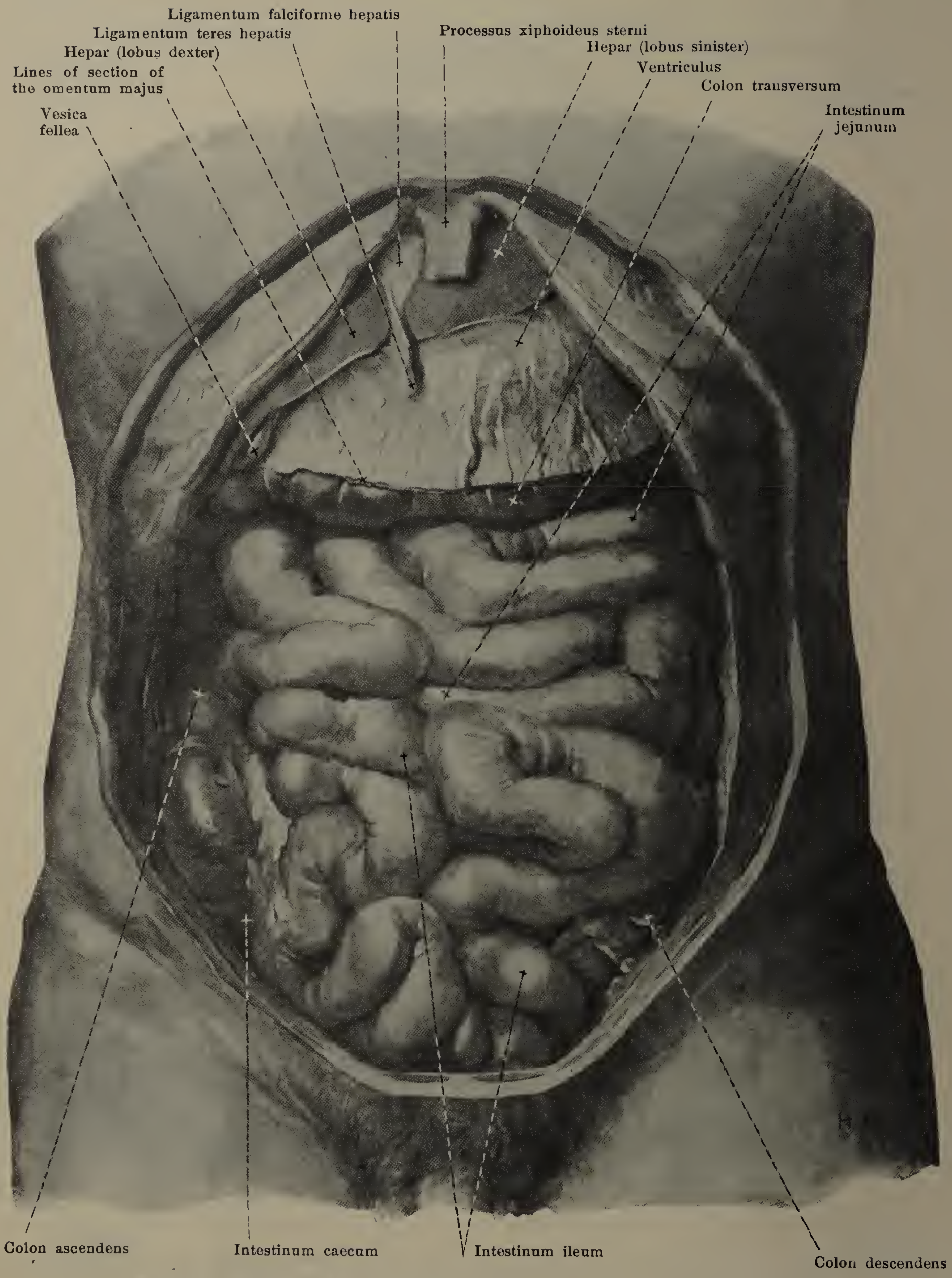
The spleen possesses a complete covering of peritonaeum *(tunica serosa)*, only the hilus being free from it. Starting from the hilus the peritonaeum extends in front as the *ligamentum gastrolienale* to the anterior layer of the great omentum and to the curvatura ventriculi major. Behind starting from the hilus the peritonaeum goes to the kidney and the inferior surface of the diaphragm as the *ligamentum phrenicolienale.*

In the ligamentum gastrolienale, in the omentum majus or in the pancreas a rounded or a long *accessory spleen, lien accessorius,* of variable size is occasionally to be found; there may be two or even many of these.



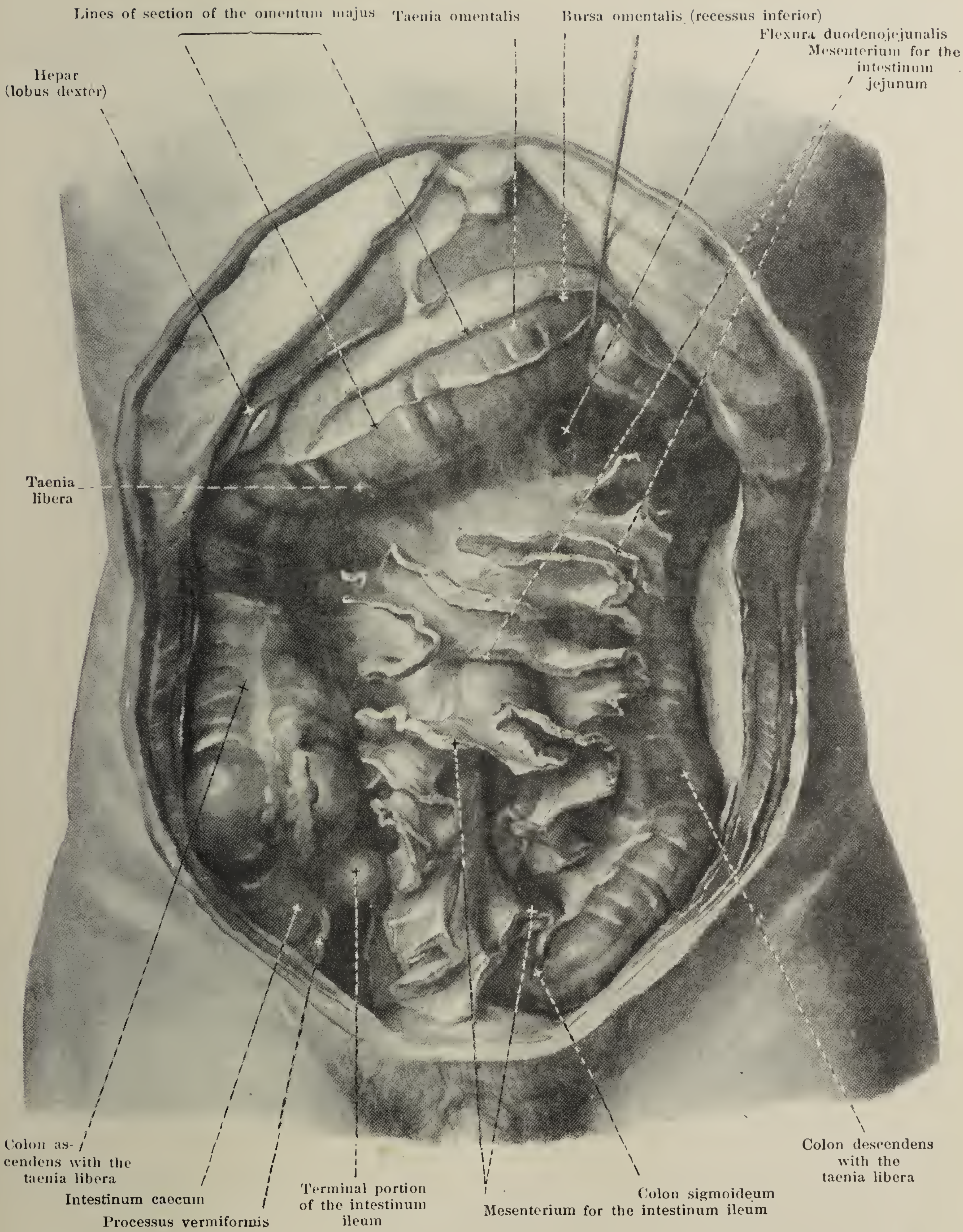
639. Abdominal viscera, viewed from in front.

(Figs. 639—642 are drawn from the same dissection. The skin and muscles of the anterior abdominal wall have been removed; their peritoneal covering has been cut through and reflected backward.)



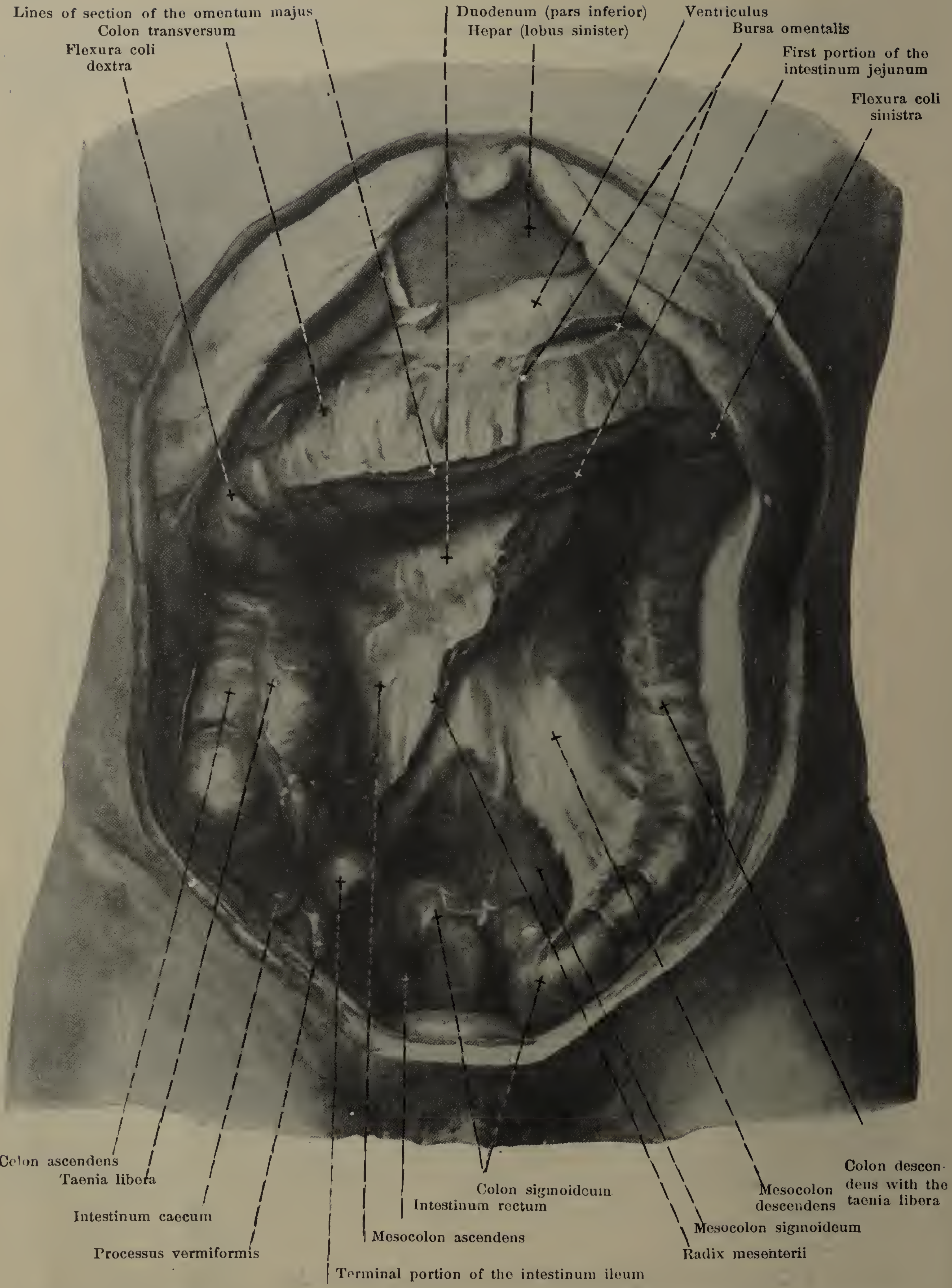
640. Small intestines, viewed from in front.

(Figs. 639—642 have been drawn from the same dissection. The anterior abdominal wall and the great omentum have been removed. In Figs. 640 and 641 the crosses have been placed upon the portions of the small intestine and of the margin of the mesentery which belong to one another. The course of the loops of the intestine is visible in Fig. 641.)


Lines of section of the omentum majus
Taenia omentalis
Bursa omentalis (recessus inferior)
Flexura duodenojejunalis
Mesenterium for the intestinum jejunum
Hepar (lobus dexter)
Taenia libera
Colon ascendens with the taenia libera
Intestinum caecum
Processus vermiformis
Terminal portion of the intestinum ileum
Mesenterium for the intestinum ileum
Colon sigmoideum
Colon descendens with the taenia libera

641. Convolutions of the mesentery, viewed from in front.

(Figs. 639—642 have been drawn from the same dissection. The colon transversum has been drawn upward. The small intestine has been cut off close to its mesentery and the course of the invisible parts of the free margin of the mesentery indicated by dotted lines. For further explanation see Fig. 640.)



642. Large intestine and root of the mesentery,
viewed from in front.

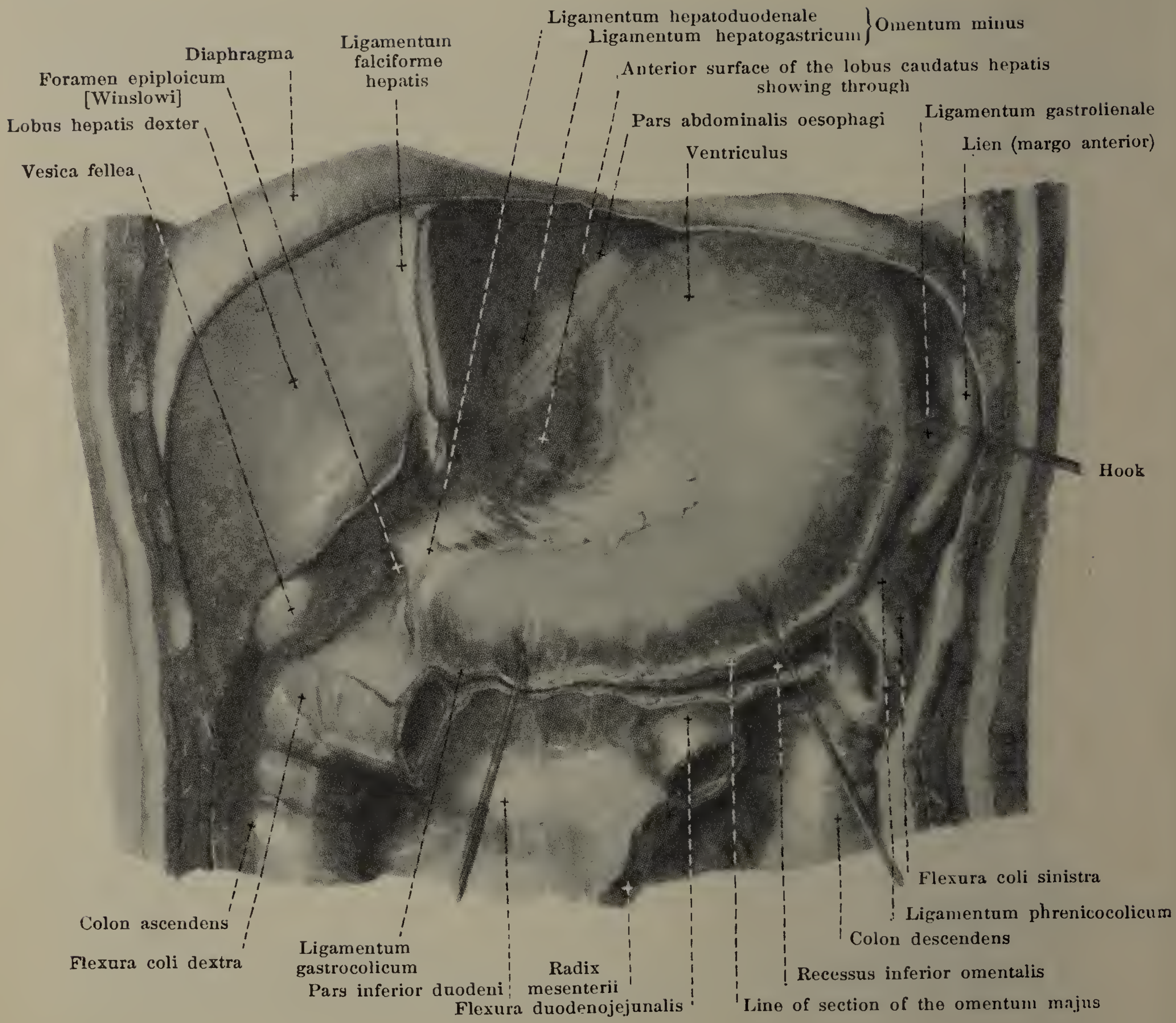
(Figs. 639—642 have been drawn from the same dissection. The mesentery of the small intestine has been cut away at its root.)

The **peritonaeum** (see Fig. 649) is the smooth glistening serous membrane, *tunica serosa*, which covers in varying degrees of completeness the walls and viscera of the abdominal and pelvic cavities; it is fastened to the tissue beneath it by a thin layer of loose connective tissue, *tela subserosa.* That part of it which covers the walls of these cavities and the large vascular and nerve trunks attached to them as well as some parts of the urinary and sexual apparatus is called the *peritonaeum parietale.* That part of it which is firmly attached to the surface of the more freely movable portions of the digestive tube, the pancreas, liver and spleen, as well as to other parts of the urinary and sexual apparatus is called the *peritonaeum viscerale;* under the latter term are also grouped the coverings of the membranes which stretch out between the abdominal wall and individual viscera or stretched out in the embryo, passing free through the abdominal cavity, and in which the vessels and nerves belonging to these viscera run. The parietal and visceral peritonaeum go directly over into one another at their margins and can therefore be grouped together as a great sac, which in the male is completely closed and in the female presents an opening only at the ostium abdominale tubae uterinae on each side. The free surface of the peritonaeum surrounds a cavity, the *peritoneal cavity (cavum peritonaei),* which is really only a capillary slit, since the viscera lie closely pressed upon one another and upon the walls of the cavity; it contains a very small amount of clear, serous fluid which moistens the surface so that the parts glide easily upon one another. The peritonaeum parietale is in general somewhat thicker than the peritonaeum viscerale and is attached rather loosely by means of the fascia transversalis to the mm. recti abdominis, the posterior layer of the vagina m. recti and to the m. transversus abdominis, more firmly to the diaphragm.

Course of the peritonaeum. From the posterior surface of the upper part of the anterior abdominal wall and from the diaphragm a fold of peritonaeum, *ligamentum falciforme hepatis* (see Figs. 630, 631, 639 and 640), runs off approximately in the median plane; it begins as a low fold at the umbilicus and gradually increasing in height extends backward and somewhat to the right to the incisura umbilicalis and to the facies superior of the liver; between the umbilicus and the incisura umbilicalis it presents a free margin, in which runs the ligamentum teres hepatis. At the impressio cardiaca of the liver the two layers of the fold diverge from one another and go over into the anterior layer of the *ligamentum coronarium hepatis* (see Figs. 630 and 631), which extends from the inferior surface of the diaphragm approximately in a frontal plane to the upper surface of the liver. On the left side this fold consists of an anterior and a posterior plate of peritonaeum which are in contact with one another; it runs as far as the appendix fibrosa hepatis and there ends in a sharp concave margin, the *ligamentum triangulare sinistrum.* On the right, the fold is formed of two plates which are in contact with one another only at its right free end, the *ligamentum triangulare dextrum,* elsewhere the posterior plate is considerably separated from the anterior, leaves the posterior surface of the right lobe of the liver uncovered and follows a course partly upon the posterior surface of the diaphragm, partly upon the anterior surface of the right kidney and suprarenal, to run in front of the same as far as the flexura coli dextra. Between the inferior surface of the liver and the kidney a special fold, the *ligamentum hepatorenale* (see Fig. 645), is often stretched out.

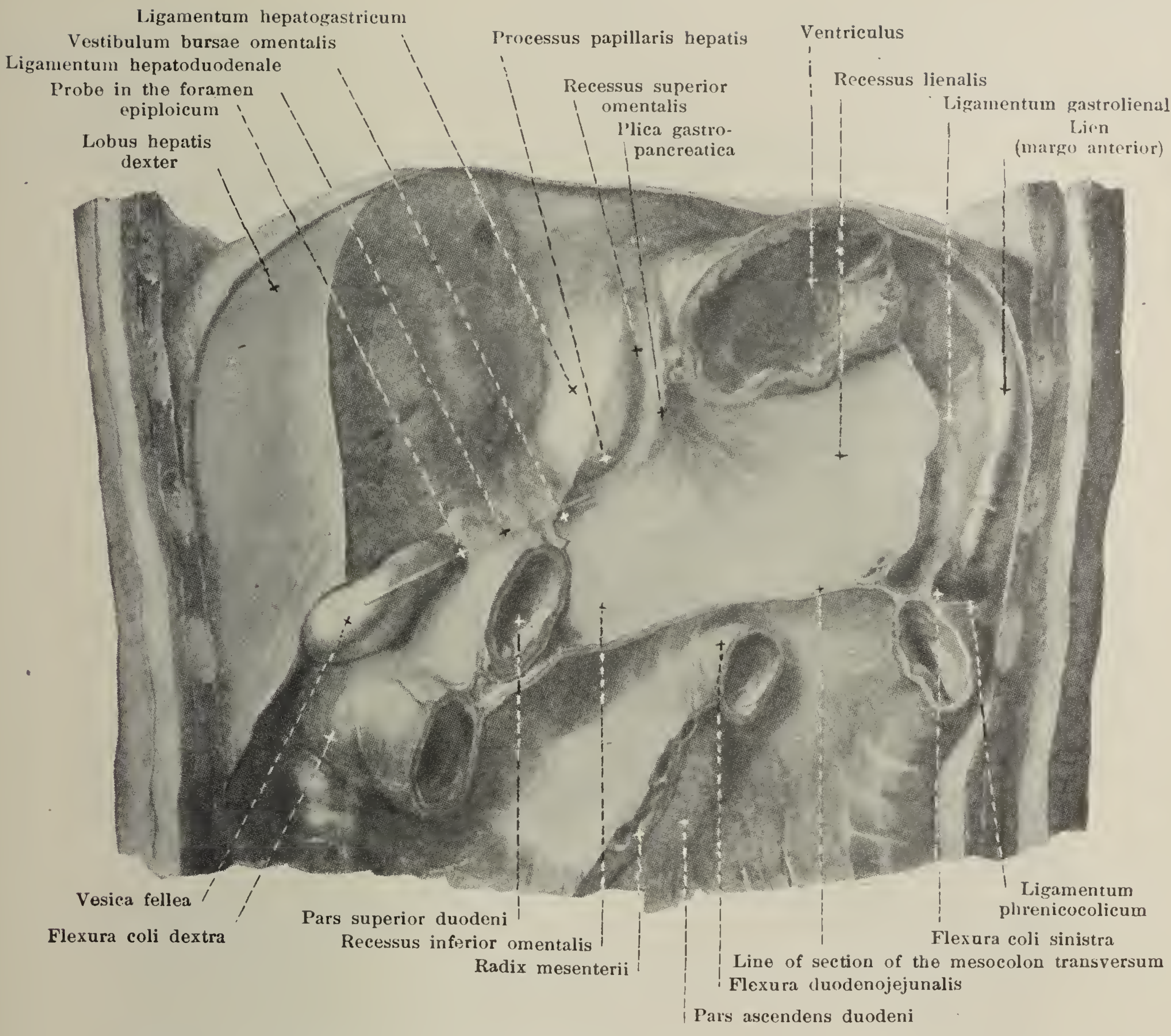
The peritonaeum covers the superior and inferior surfaces of the liver and extends (see Figs. 643 and 644) from the fossa ductus venosi and from the porta hepatis to the inferior surface of the diaphragm, to the right side of the pars abdominalis of the oesophagus, to the curvatura ventriculi minor and to the upper surface of the pars superior duodeni in a duplicature as the ***lesser omentum,*** *omentum minus,* and then covers these organs. The omentum minus is a membrane of variable strength, the anterior layer of which is going to the anterior surfaces of the organs named, the posterior layer belonging to the bursa omentalis (see p. 561); the portion going to the oesophagus and stomach is called the *ligamentum hepatogastricum;* in its upper sickle-shaped portion, which goes to the oesophagus and cardia, it is striped and stout, in its lower part attached to the curvatura minor it is very thin and loose. To the latter on the right side without sharp limit is attached the portion of the omentum minus, which extends from the porta hepatis to the duodenum, *ligamentum hepatoduodenale;* this is thick, ends on the right in a free, slightly concave margin (see also Fig. 645) and contains within it the a hepatica propria (to the left and in front), the v. portae (in the middle and behind) and the ductus choledochus (to the right and in front) (see Figs. 548 and 635), as well as the plexus hepaticus s. sympathici and lymph vessels. From the anterior surface of this ligament there often arises a fold which runs from the posterior surface of the gall bladder either only as far as the pars descendens duodeni or even *(ligamentum hepatocolicum,* see Fig. 645), to the colon transversum. From the region where the free margin of the lig. hepatoduodenale ends below, a smaller fold, *ligamentum duodenorenale* (see Fig. 645), often extends to the anterior surface of the right kindney.

The peritonaeum covers the anterior superior surface of the stomach and on the left side at the curvatura major goes backward as the broad *ligamentum gastrolienale* (see Fig. 643) to the facies gastrica of the spleen, covers the spleen and passes from its facies renalis as the *ligamentum phrenicolienale* (not illustrated) around to the left kidney and the diaphragm.


Ligamentum hepatoduodenale
Ligamentum hepatogastricum
Omentum minus
Diaphragma
Ligamentum falciforme hepatis
Foramen epiploicum [Winslowi]
Lobus hepatis dexter
Vesica fellea
Anterior surface of the lobus caudatus hepatis showing through
Pars abdominalis oesophagi
Ventriculus
Ligamentum gastrolienale
Lien (margo anterior)
Hook
Flexura coli sinistra
Ligamentum phrenicocolicum
Colon descendens
Recessus inferior omentalis
Line of section of the omentum majus
Colon ascendens
Flexura coli dextra
Ligamentum gastrocolicum
Pars inferior duodeni
Radix mesenterii
Flexura duodenojejunalis

643. Lesser omentum ***(omentum minus),*** viewed from in front.
(The left lobe of the liver has been completely removed, the colon transversum in largest part; the stomach has been drawn somewhat downward, the spleen somewhat to the left.)

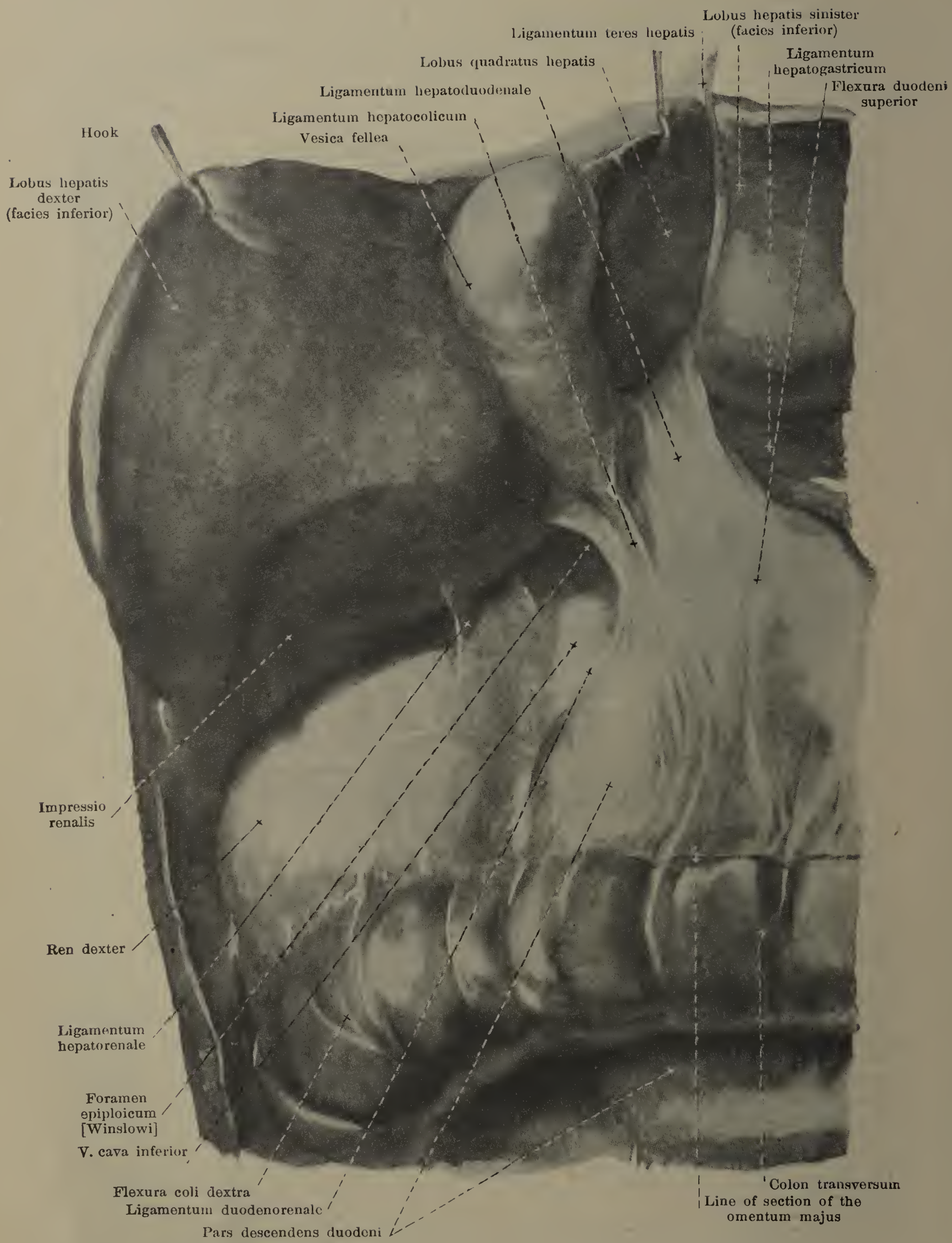
Course of the peritonaeum (continued). Hanging downward from the curvatura major of the stomach like an apron in front of the colon transversum and in front of the small intestine for a variable distance and ending below in a jagged margin is the great omentum, ***omentum majus.*** (see Fig. 639). This broad peritoneal appendage is for the most part thin and transparent, but often contains large accumulations of fat along the vessels. In youth it consists of four layers (see also Fig. 649) of which the two anterior and two posterior ones are grown together; the two anterior proceed at the curvatura ventriculi major directly from the tunica serosa of the paries anterior et posterior ventriculi; the two posterior are continued at the taenia omentalis of the colon transversum into the tunica serosa of the colon transversum and into the mesocolon transversum; at the free margin the two outer layers and the two inner layers go directly over into one another. In the embryonal period (see Fig. 649) the two posterior layers extend above the colon transversum as far as the posterior abdominal wall; later however the mesocolon transversum and its intestine come into contact from below with this portion of the primary great omentum and fuse with it. The recessus inferior omentalis(see p.561) extends originally into the great omentum as far as its free margin, but vanishes in youth or later often more or less completely owing to a fusion of the two middle layers of peritonaeum bounding this space. When this fusion has advanced as far as the colon transversum (which happens earlier on the right side than on the left), the two anterior layers of the great omentum extend from the curvatura ventriculi major wholly or partly directly to the colon transversum and form a ligamentum *gastrocolicum:* from there the omentum majus is hanging down as an uniform plate. On the left side the two anterior layers go over directly into the *ligamentum gastrolienale* (see p. 559) and are connected with the *ligamentum phrenicocolicum* (see p. 554).


Ligamentum hepatogastricum
Vestibulum bursae omentalis
Ligamentum hepatoduodenale
Probe in the foramen epiploicum
Lobus hepatis dexter
Processus papillaris hepatis
Recessus superior omentalis
Plica gastro-pancreatica
Ventriculus
Recessus lienalis
Ligamentum gastrolienale
Lien (margo anterior)
Vesica fellea
Flexura coli dextra
Pars superior duodeni
Recessus inferior omentalis
Radix mesenterii
Pars ascendens duodeni
Flexura duodenojejunalis
Line of section of the mesocolon transversum
Flexura coli sinistra
Ligamentum phrenicocolicum

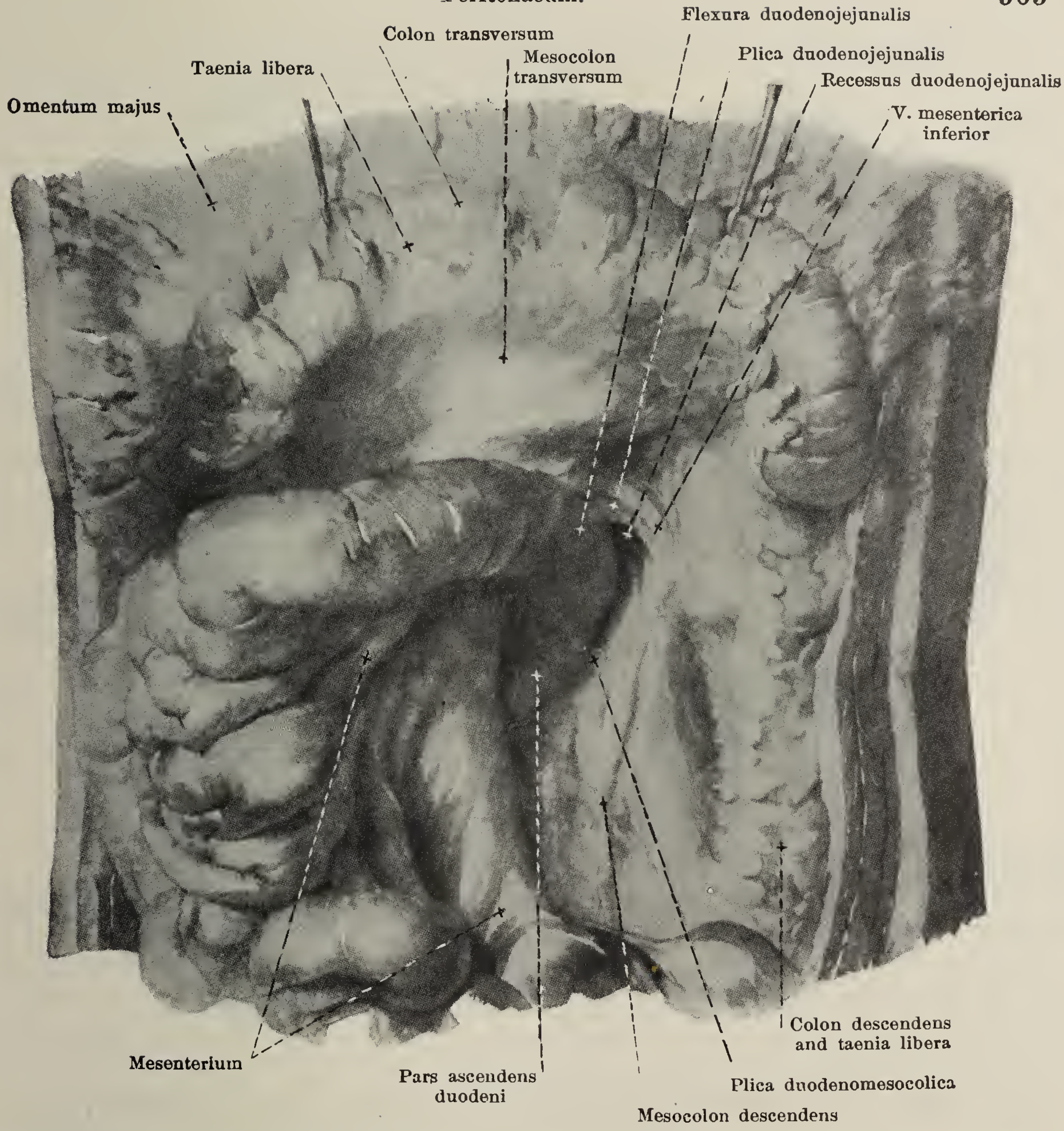
644. Bursa omentalis, opened, viewed from in front.

(From the dissection illustrated in Fig. 643 a piece of the right lobe of the liver has been removed and also the stomach in its largest part; the mesocolon transversum has been cut off shorter.)

Course of the peritonaeum (continued). The ***omental bursa,*** *bursa omentalis* (O. T. lesser peritoneal cavity) (see also Fig. 649) is a slit-like cavity surrounded on all sides by peritonaeum, which is connected with the general cavum peritonaei at one spot only. This opening, *foramen epiploicum [Winslowi]* (see also Figs. 643 and 645), is bounded in front by the ligamentum hepatoduodenale, above by the processus caudatus of the liver, behind by the v. cava inferior and below by the flexura duodeni superior. A narrow passage, *vestibulum bursae omentalis,* leads out from it under the processus caudatus and over the caput pancreatis to the left as far as the sickle-shaped fold projecting in the median plane, the *plica gastropancreatica,* in which the a. gastrica sinistra and v. coronaria ventriculi run from the tuber omentale pancreatis to the right side of the cardia. Ascending vertically upward from the vestibulum as a narrow prolongation behind the ligamentum hepatogastricum and lobus caudatus [Spigeli] and in front of the pars lumbalis diaphragmatis is the *recessus superior omentalis;* it clothes these parts with its peritonaeum. Near the plica gastropancreatica is the passage into the main portion which as the *recessus inferior omentalis* extends downward from the cardia into the great omentum; its anterior wall is formed by the paries posterior of the stomach, its posterior by the anterior surface of the left suprarenal, of the upper part of the left kidney and of the pancreas, as well as by the mesocolon transversum and the colon transversum; all of these parts possess a peritoneal covering belonging to the bursa omentalis. Concerning the inferior portion of the recessus inferior situated in the omentum majus see p. 560. On the left side the bursa omentalis extends as the *recessus lienalis* behind the ligamentum gastrolienale almost as far as the hilus of the spleen (see also Fig. 638). This bursa omentalis may be diminished in size in old age by partial fusion of its peritoneal walls.



645. Entrance to the omental bursa,
the liver having been drawn upward.

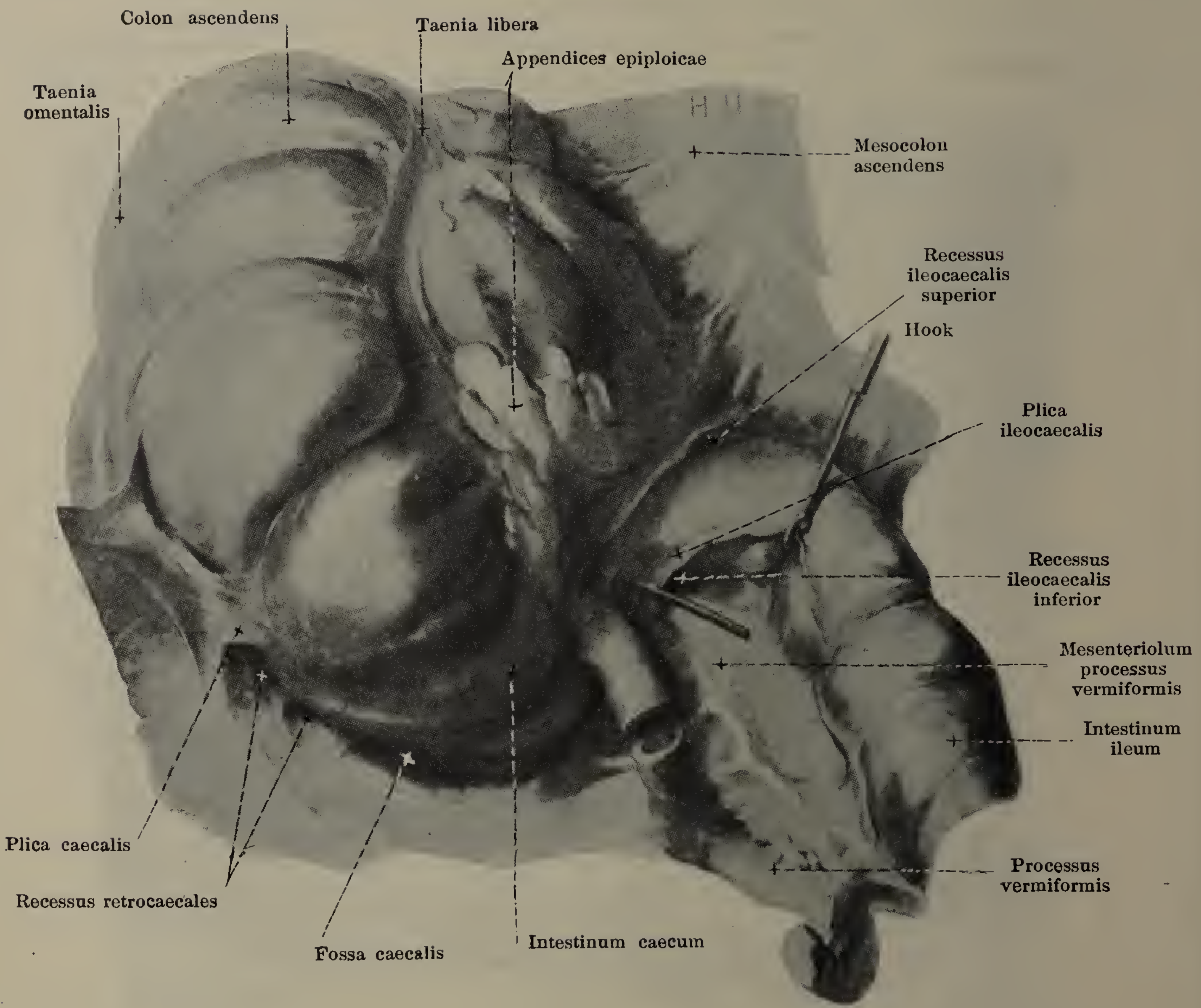


646. Recessus duodenojejunalis, viewed from in front.

(The colon transversum is drawn upward, the small intestine with the mesentery to the right.)

Course of the peritonaeum (continued). From the flexura duodenojejunalis on there arises from the posterior wall of the abdomen a large fold of peritonaeum, the ***mesenterium (mesentery)***, the starting point of which, ***radix mesenterii*** (root of the mesentery) (see Figs. 642 and 644), extends from the left side of the body of the second lumbar vertebra obliquely downward and somewhat to the right in front of the pars ascendens duodeni, the aorta abdominalis, the v. cava inferior and the right ureter to the right articulatio sacroiliaca. The mesentery consists of a layer of connective tissue, ***lamina mesenterii propria***, in which are situated the vessels, lymph glands, nerves and masses of fat and is covered on both sides by the tunica serosa. It is narrow at its starting point, then broadens fairly suddenly and presents many markedly zigzag-shaped tortuous folds (see Fig. 641) and is finally attached to the whole extent of the intestinum tenue mesenteriale; its peritoneal covering goes over into the tunica serosa of the intestine (see Fig. 649). The length of the mesentery measured from its starting point to the intestine increases distalward from the flexura duodenojejunalis on, is longest on those loops which descend into the true pelvis (see p. 536), and then again becomes shorter.

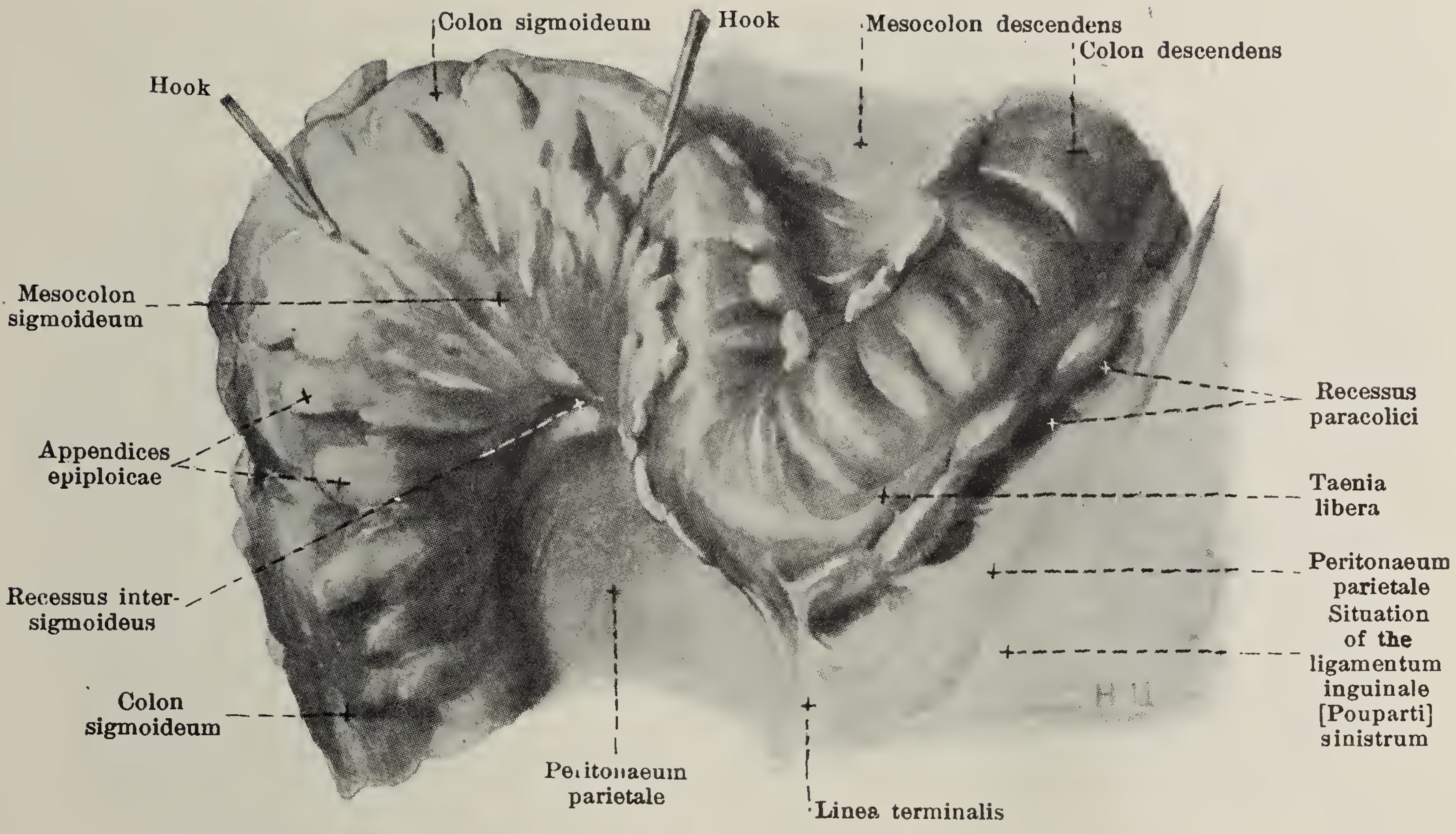
Above, extending to the left from the flexura duodenojejunalis is a variably developed sickle-shaped fold of peritonaeum, the ***plica duodenojejunalis***, which may contain the main stem of the v. mesenterica inferior; somewhat deeper there often goes off from the pars ascendens duodeni a narrower fold, ***plica duodenomesocolica.*** Their free edges are directed toward one another. These folds bound the ***recessus duodenojejunalis.***



647. Peritoneal pockets near the caecum,
viewed from in front.

(The small intestine has been drawn to the left, the vermiform process has been cut into.)

Course of the peritonaeum (continued). Up to the fourth month of embryonic life the large intestine is movably hung by its ***mesocolon,*** a duplicature of the peritonaeum, exactly in the way that the small intestine is hung by its mesentery; it is connected with the peritonaeum parietale in front of the spinal column only. Originally both kidneys, the ureters and vasa spermatica interna as well as the mm. quadratus lumborum and iliopsoas on each side are also covered by (primary) peritonaeum parietale. Subsequently, however, the movability of the large or thick intestine becomes lost owing to the fact that the mesocolon and large intestine come into relation to neighboring portions of the peritonaeum and fuse with them in variable extent. This happens in the following way: the colon ascendens and its fold of peritonaeum, *mesocolon ascendens,* becomes attached in the fourth month of the embryo to the posterior abdominal wall to the right of the radix mesenterii and the posterior layer of the mesocolon fuses with the peritonaeum parietale originally present there. After this fusion i. e. secondary, the peritonaeum parietale becomes directly continuous with the tunica serosa of the right wall of the colon ascendens, and the posterior wall of the latter no longer possesses a peritoneal covering. The fusion does not extend usually as far as the intestinum caecum (see p. 540). Behind this, therefore, is found a prolongation of the peritoneal cavity open below, the *fossa caecalis;* it is bounded on the right by the *plica caecalis,* which is stretched out downward from the right inferior extremity of the surface of fusion. From the cupula of the fossa caecalis extend upward not infrequently one or several small depressions, *recessus retrocaecales,* the origin of which is to be explained in irregularities in the fusion of the colon to the peritonaeum parietale.



648. Recessus intersigmoideus,

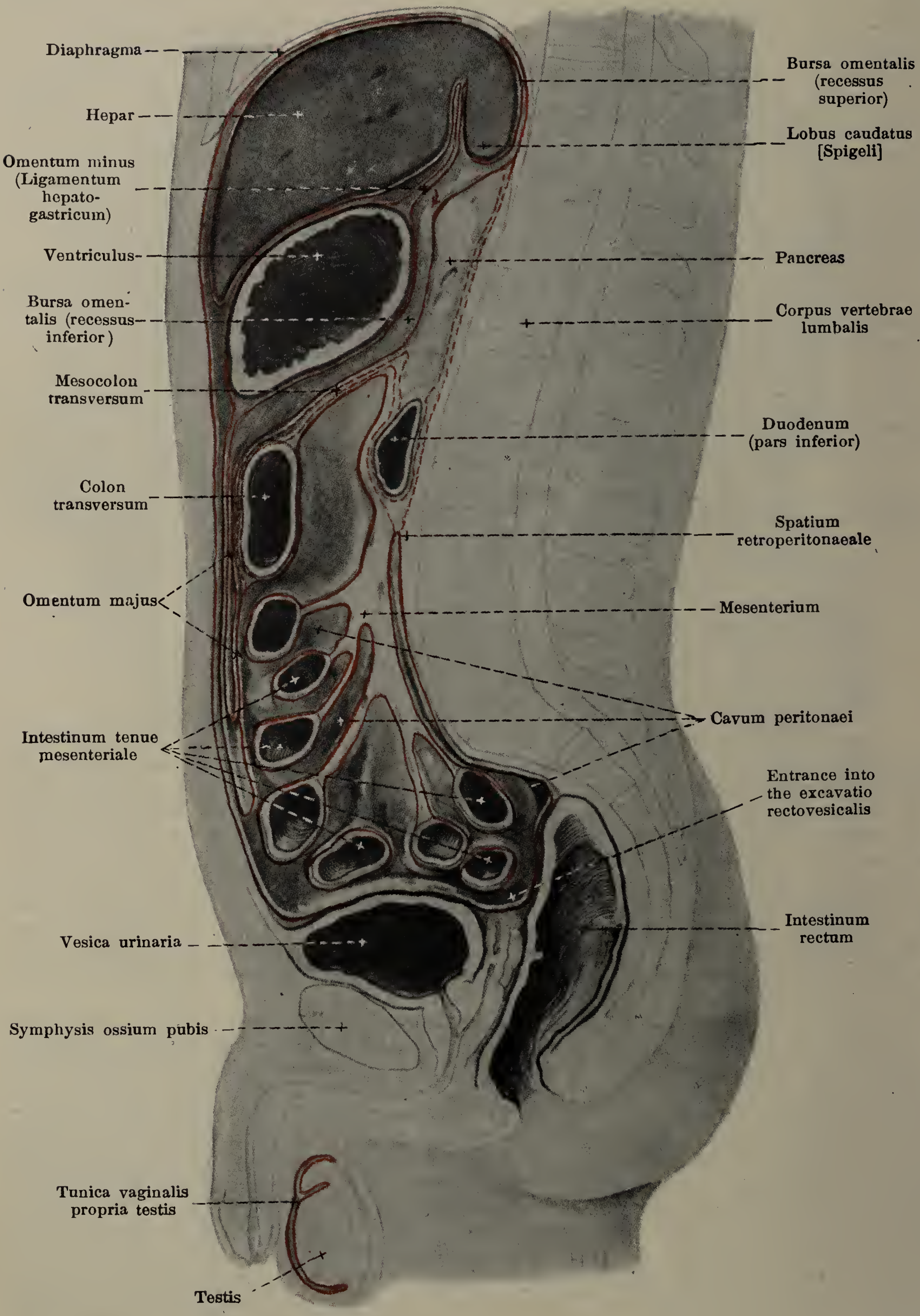
viewed from in front and below.

(The colon sigmoideum has been drawn upward.)

Course of the peritonaeum (continued). Behind the terminal portion of the intestinum ileum there arises from the posterior wall an approximately quadrangular fold of peritonaeum, the ***mesenteriolum processus vermiformis*** (see Fig. 647). This is attached to the taenia mesocolica of the caecum and to the upper margin of the processus vermiformis, going over there into its tunica serosa. From the anterior wall of the last piece of small intestine extends a variably developed fold of peritonaeum, the ***plica ileocaecalis***, to the caecum and to the anterior surface of the mesenteriolum (see Fig. 647). It contains smooth muscle fibres and bounds from in front the ***recessus ileocaecalis inferior***, which is very variable in size and open downward and to the left. Above this portion of the small intestine a narrow triangular fold of peritonaeum goes to the right and downward from the anterior surface of the mesentery in front of the small intestine to the large intestine; it forms the anterior wall of the ***recessus ileocaecalis superior*** (see Fig. 647) which is usually small and open toward the left.

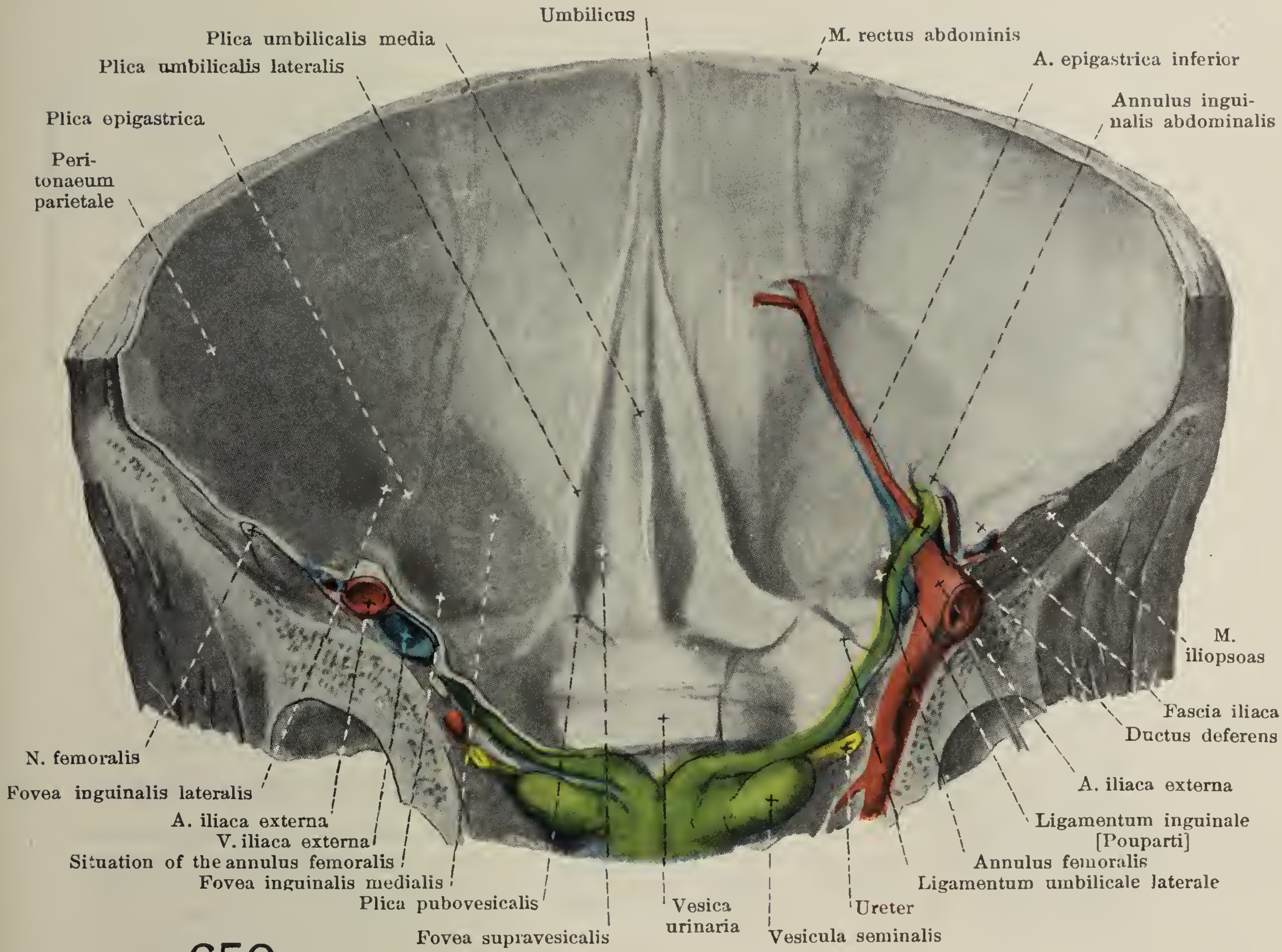
The colon transversum and its duplicature of peritonaeum, the ***mesocolon transversum***, in the fourth month of the embryo lies on the right side on the primary peritonaeum parietale in as far as it covers the inferior portion of the pars descendens duodeni, the pars inferior duodeni and the processus uncinatus pancreatis. The posterior layer of the mesocolon transversum then fuses there with the (primary) peritonaeum parietale so that later the peritonaeum goes over (secondarily) directly from the anterior surface of the right kidney and of the upper part of the pars descendens duodeni to the colon transversum (see Fig. 645). On the left the mesocolon transversum becomes attached from below to the two posterior layers of the primary omentum majus (see p. 560 and Fig. 649) which went originally as far as the posterior abdominal wall, and its upper layer, as well as the tunica serosa of the upper surface of the colon transversum, fuses with the most posterior layer of the primary omentum majus. Later, as a result of this, the two posterior layers of the omentum majus are directly attached to the colon transversum so that the latter lies as it were between these layers of the great omentum, and the upper surface of the colon transversum, as well as the upper layer of the mesocolon transversum, looks into the bursa omentalis.

The colon descendens and its fold of peritonaeum, ***mesocolon descendens***, lies in the fifth month of the embryo on the left of the spine on the posterior abdominal wall and fuses there with the (primary) peritonaeum parietale exactly as does the mesocolon ascendens on the right; this fusion reaches below usually as far as the medial margin of the left m. psoas major (see also Fig. 686), but it may fail to take place to a variable extent in the fossa iliaca. Small fossae on the left side which lead behind the colon, ***recessus paracolici***, arise in very much the same way as do the recessus retrocaecales (see p. 564).


Diaphragma
Hepar
Omentum minus (Ligamentum hepato-gastricum)
Ventriculus
Bursa omentalis (recessus inferior)
Mesocolon transversum
Colon transversum
Omentum majus
Intestinum tenue mesenteriale
Vesica urinaria
Symphysis ossium pubis
Tunica vaginalis propria testis
Testis
Bursa omentalis (recessus superior)
Lobus caudatus [Spigeli]
Pancreas
Corpus vertebrae lumbalis
Duodenum (pars inferior)
Spatium retroperitonaeale
Mesenterium
Cavum peritonaei
Entrance into the excavatio rectovesicalis
Intestinum rectum

649. Course of the peritonaeum, red, in a median section of a male (after W. Braune), somewhat schematic.

(The dotted red lines refer to the embryonic conditions [see pp. 560 and 565].)



650.

Anterior abdominal wall of a male (inferior half),
viewed from behind.

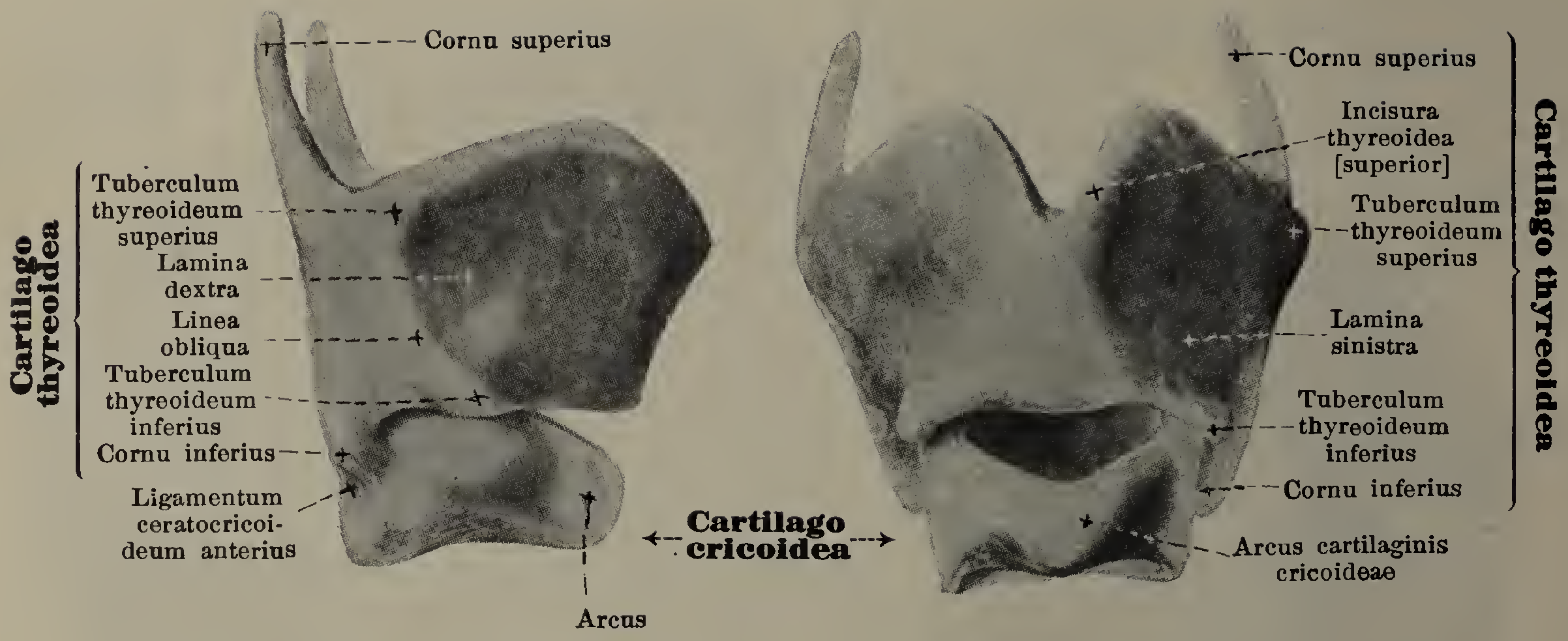
(The posterior part of the pelvis has been removed by a frontal section; the peritonaeum has been partly dissected away on the right side. Cf. Fig. 379. The bladder is empty.)

Course of the peritonaeum (continued). The colon sigmoideum and its duplicature of peritonaeum, ***mesocolon sigmoideum,*** does not fuse with the peritonaeum parietale but remains always freely movable. The starting point of this mesocolon forms a /\ (see Fig. 686), the left limb of which corresponds to the inferior extremity of the surface of fusion of the mesocolon descendens (see p. 565), and its right limb extends downward and to the right in front of the promontorium. From the appex of the /\ a funnel-shaped prolongation, ***recessus intersigmoideus,*** of varying size extends upward along the aa. sigmoideae (see Figs. 648 and 686).

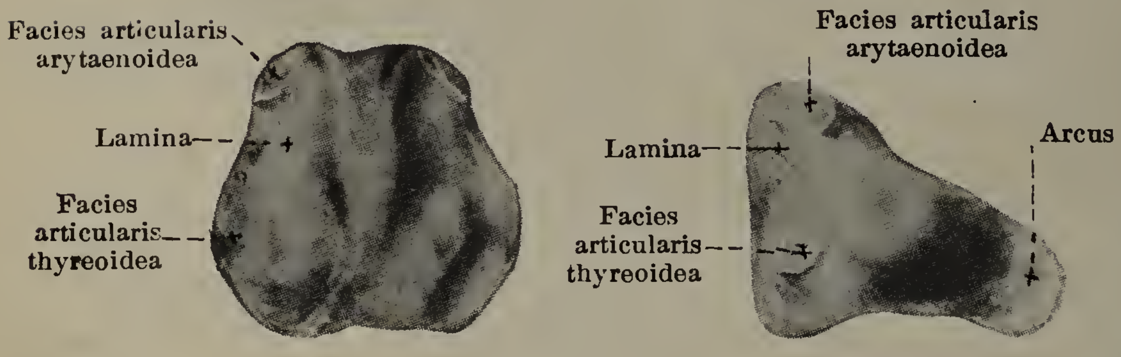
The duodenum with the pancreas are also originally freely movable by a plate of peritonaeum but later like the colon become firmly attached to the posterior abdominal wall owing to the fact that posterior surface of the peritoneal plate fuses with the peritonaeum parietale.

The space situated behind the primary peritonaeum parietale, and which contains the suprarenal glands, the kidneys, the ureters, the large vessels as well as their paired branches and the large nerves, is called the ***spatium retroperitonaeale (retroperitoneal space).***

The posterior surface of the anterior abdominal wall is covered by the ***peritonaeum parietale.*** From this arise, below the umbilicus, five folds (see also Fig. 379). The ***plica umbilicalis media,*** which is made to project by the ligamentum umbilicale medium (see p. 601), runs approximately in the median plane; the ***plica umbilicalis lateralis,*** in which is situated the ligamentum umbilicale laterale (see p. 446), extends downward and lateralward to the pelvic inlet. The plicae umbilicales are sometimes indistinct, usually low above, higher below; they usually fuse somewhat below the navel. Between these folds on each side, above the pubis and behind the m. rectus abdominis, lies the ***fovea supravesicalis.*** Further lateralward is situated the ***plica epigastrica*** which is caused to project by the a. and vv. epigastricae inferiores; it is distinct below only. Lateralward from it, behind the annulus inguinalis abdominalis, lies the ***fovea inguinalis lateralis,*** medianward from it the ***fovea inguinalis medialis,*** from this, leading in front of the plica umbilicalis lateralis, a pocket very often extends medianward.


Cornu superius
Cartilago thyreoidea
Tuberculum thyreoideum superius
Lamina dextra
Linea obliqua
Tuberculum thyreoideum inferius
Cornu inferius
Ligamentum ceratocricoideum anterius
Arcus
Cartilago cricoidea
Cornu superius
Incisura thyreoidea [superior]
Tuberculum thyreoideum superius
Lamina sinistra
Tuberculum thyreoideum inferius
Cornu inferius
Arcus cartilaginis cricoideae
Cartilago thyreoidea

651 and 652. Thyroid and cricoid cartilages,
viewed from the right. viewed from in front.

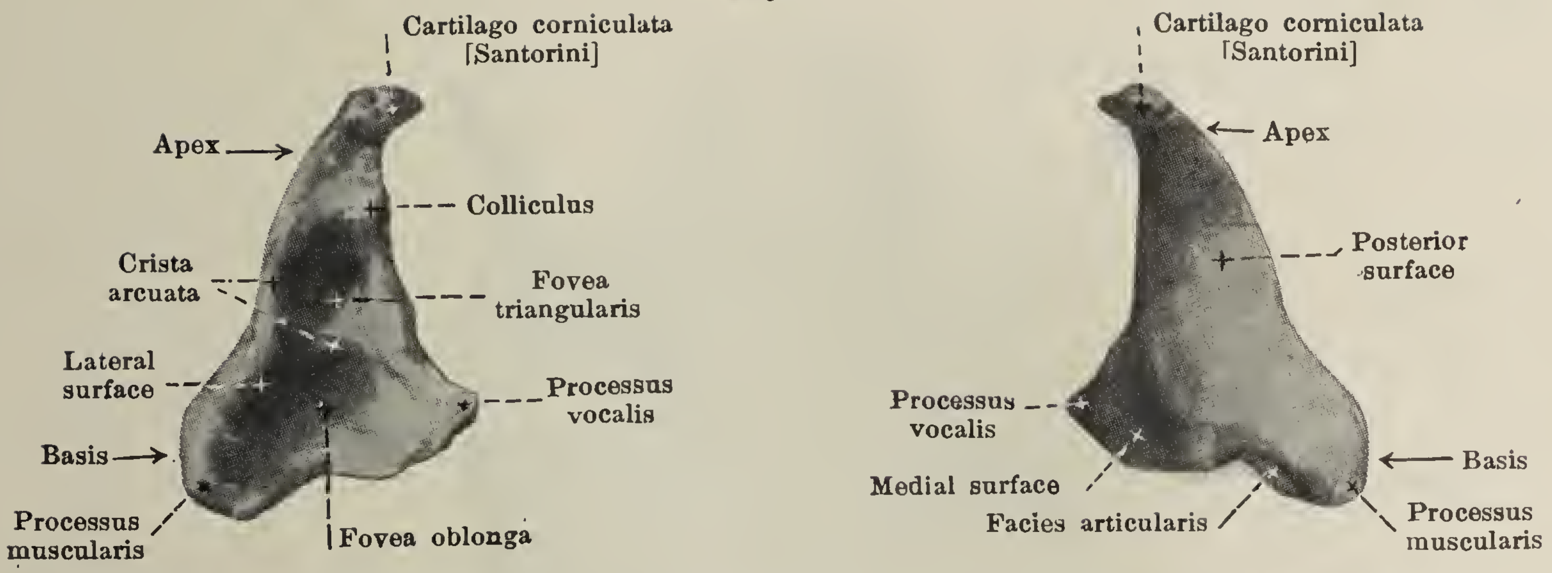

Facies articularis arytaenoidea
Lamina
Facies articularis thyreoidea
Facies articularis arytaenoidea
Lamina
Facies articularis thyreoidea
Arcus

653 and 654. Cricoid cartilage,
viewed from behind. viewed from the right.

The **larynx** (see Figs. 567 and 660) is an oblong hollow body which lies in the middle of the neck, below the hyoid bone, in front of the lower half of the cervical spine. It is bounded in front in the median plane directly by the fascia colli and the skin (bursa [mucosa] subcutanea prominentiae laryngeae see p. 275), is covered lateralward partly by the thyroid gland and the mm. sternohyoidei, sternothyreoidei, thyreohyoidei, omohyoidei and constrictores pharyngis inferiores and is bounded behind by the pars laryngea pharyngis. Above it opens through the aditus laryngis into the pharynx, below it goes over into the trachea. In the male it is absolutely and relatively larger than in the female. It possesses a cartilaginous framework.

Cartilages of the larynx *(cartilagines laryngis).* They ossify almost completely in old age but later in the female than in the male. Ossification occurs in the 15th to 20th year.

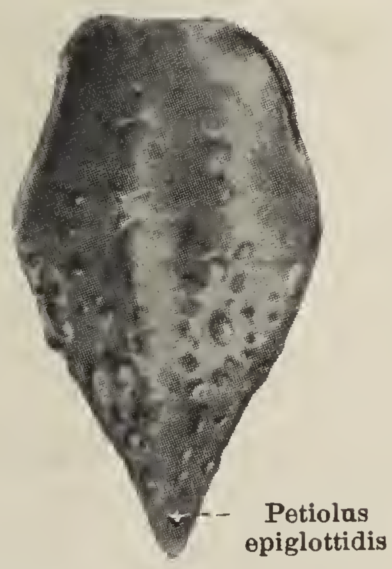
Cartilago thyreoidea *(thyroid cartilage)* (see also Fig. 663), unpaired, is the largest hyaline cartilage and lies in the anterior superior part of the larynx. It is formed of two quadrangular *plates, laminae [dextra et sinistra]*, which converge in front and below and in the male meet at an angle (above about 90°), in the female they go over into one another in the form of an arch. The line of junction in the male runs obliquely backward and downward; its uppermost, most anterior point causes a projecting of the skin, *prominentia laryngea* (see Fig. 567), which is scarcely noticeable in the female. The inner surface is smooth; the outer surface frequently presents a flat ridge behind extending from above and behind downward and forward, the *linea obliqua* (for the mm. sternothyreoideus, thyreohyoideus and thyreopharyngeus); this begins above in a triangular nodule, *tuberculum thyreoideum superius,* and ends below in a smaller ridge-like projection of the inferior margin, *tuberculum thyreoideum inferius.* Below the tuberculum superius there is frequently an opening, *foramen thyreoideum* (see Fig. 660), of variable size. The upper margin is curved so as to be convex on each side; in the middle at the junction of the right and left upper margins is a notch of variable depth, *incisura thyreoidea [superior].* The inferior margin presents on each side two flat depressions of variable development. From the posterior margin which is almost straight on each side projecting upward and a little backward is the *cornu superius,* projecting downward and a little forward the shorter *cornu inferius.* Both are rounded and curved somewhat medianward; the inferior presents on the median decline of its apex a rounded articular surface (for the facies articularis thyreoidea of the cartilago cricoidea).



655 and 656. Right arytaenoid cartilage,

viewed from in front and lateralward. viewed from behind and medianward.

Magnification: 3: 2.



657. Cartilage of the epiglottis,

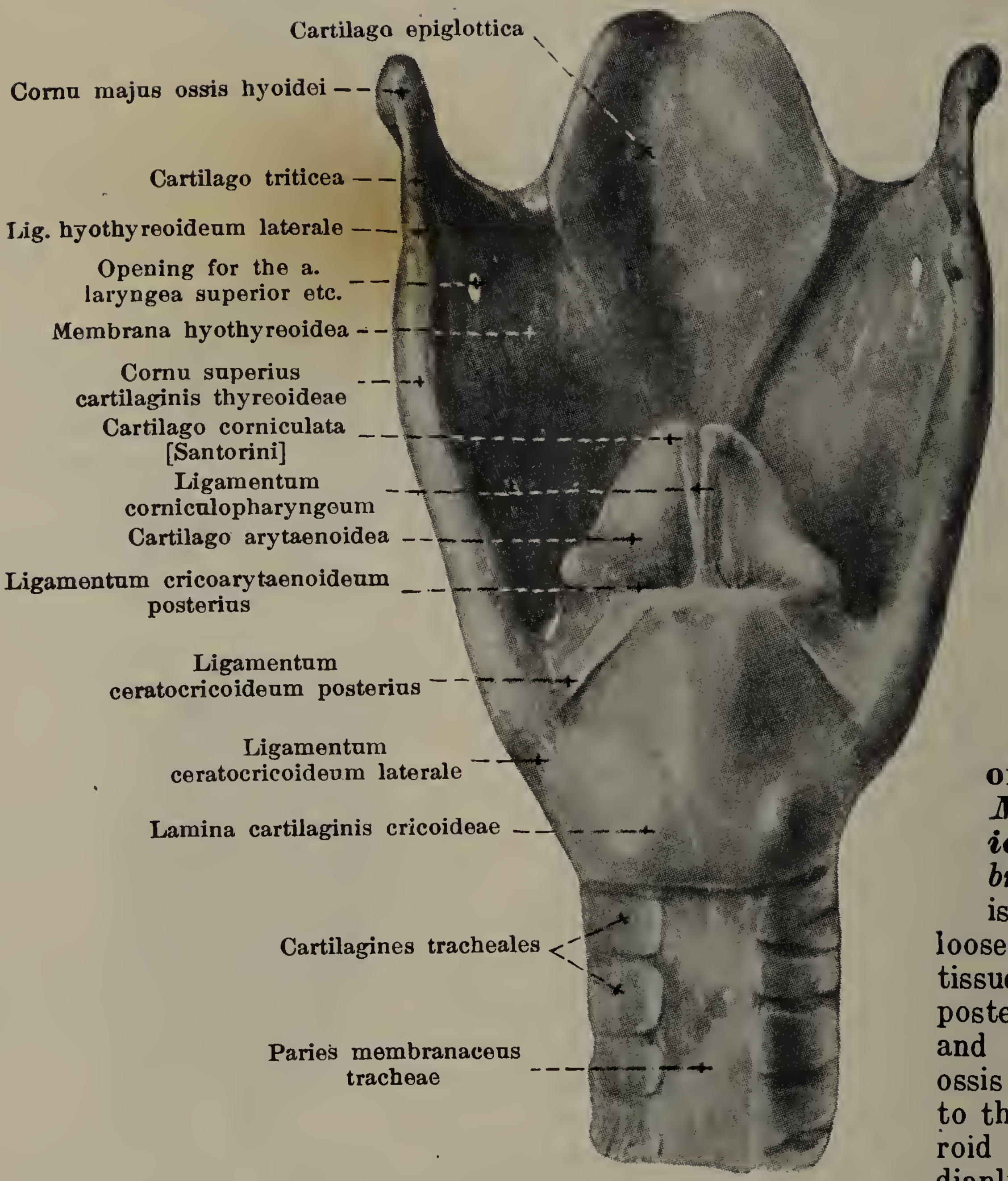
viewed from behind.

Cartilago cricoidea *(ring cartilage or cricoid cartilage)* (see Figs. 651—654), unpaired, consists of hyaline cartilage and lies below the thyroid cartilage. It has the shape of a seal ring. The anterior portion, *arcus*, is low in front and becomes gradually higher behind. The posterior portion, *lamina*, is approximately hexagonal and higher; it lies in a frontal plane and projects upward between the posterior margins of the thyroid cartilage. Its anterior surface is smooth, its posterior presents two flat fossae (for the mm. cricoarytaeniodei posteriores), separated by a median ridge. Each lateral superior angle of the lamina bears a small articular surface looking upward, forward and lateralward, the *facies articularis arytaenoidea* (for the facies articularis of the cartilago arytaenoidea); this surface is cylindrically curved. Each lateral middle angle of the lamina possesses a small rounded articular surface, *facies articularis thyreoidea* (for the cornu inferius of the cartilago thyreoidea).

Cartilago arytaenoidea *(arytaenoid cartilage)* (see also Figs. 658 and 663), paired, lies above the lamina of the cricoid cartilage in the posterior part of the larynx and consists of hyaline cartilage with the exception of the processus vocalis and often the apex which are elastic cartilage. It has approximately the form of a three-sided pyramid. The posterior surface is markedly concave (for the m. arytaenoideus transversus); the medial, narrow surface is flat and stands sagittally. The lateral surface looking at the same time forward presents close below the apex a small nodule, the *colliculus*. From this a ridge, *crista arcuata*, goes first backward then forward and downward to the processus vocalis; it forms the margin of a deep fossa, *fovea triangularis*, and separates it from a larger, flatter depression, *fovea oblonga* (for the m. vocalis). The oblong, somewhat obliquely placed *basis* presents behind a rounded, concave *facies articularis* (for the facies articularis arytaenoidea of the cartilago cricoidea); directly above this lies the lateral blunt angle, *processus muscularis*, for the mm. cricoarytaenoidei. The anterior angle of the basis, *processus vocalis*, is longer and tapered. The tip, *apex*, is blunt and curved backward; it carries a short wedge-shaped appendage, the ***cartilago corniculata [Santorini]***, which consists of elastic cartilage and is directed backward and medianward.

Cartilago cuneiformis [Wrisbergi], paired, consisting of elastic cartilage, often lies as an oblong rod close in front of the cartilago corniculata in the posterior part of the plica aryepiglottica (see Fig. 666 in the projection beneath the tuberculum cuneiforme).

Cartilago epiglottica *(cartilage of the epiglottis)* (see also Figs. 658, 659 and 666), unpaired, consisting of elastic cartilage, is thin, very flexible, shaped like the ace of hearts, multiply perforated and presents numerous small depressions; it is situated above the thyroid cartilage behind the root of the tongue and the hyoid bone and directed obliquely backward and upward. It presents below a thicker tip, *petiolus epiglottidis*, above frequently a notched margin. Its posterior surface is curved so as to be saddle-shaped, being slightly convex backward in the sagittal direction, markedly concave in the transversal direction.


Cartilago epiglottica
Cornu majus ossis hyoidei
Cartilago triticea
Lig. hyothyreoideum laterale
Opening for the a. laryngea superior etc.
Membrana hyothyreoidea
Cornu superius cartilaginis thyreoideae
Cartilago corniculata [Santorini]
Ligamentum corniculopharyngeum
Cartilago arytaenoidea
Ligamentum cricoarytaenoideum posterius
Ligamentum ceratocricoideum posterius
Ligamentum ceratocricoideum laterale
Lamina cartilaginis cricoideae
Cartilagines tracheales
Paries membranaceus tracheae

658. Larynx with its ligaments, viewed from behind.

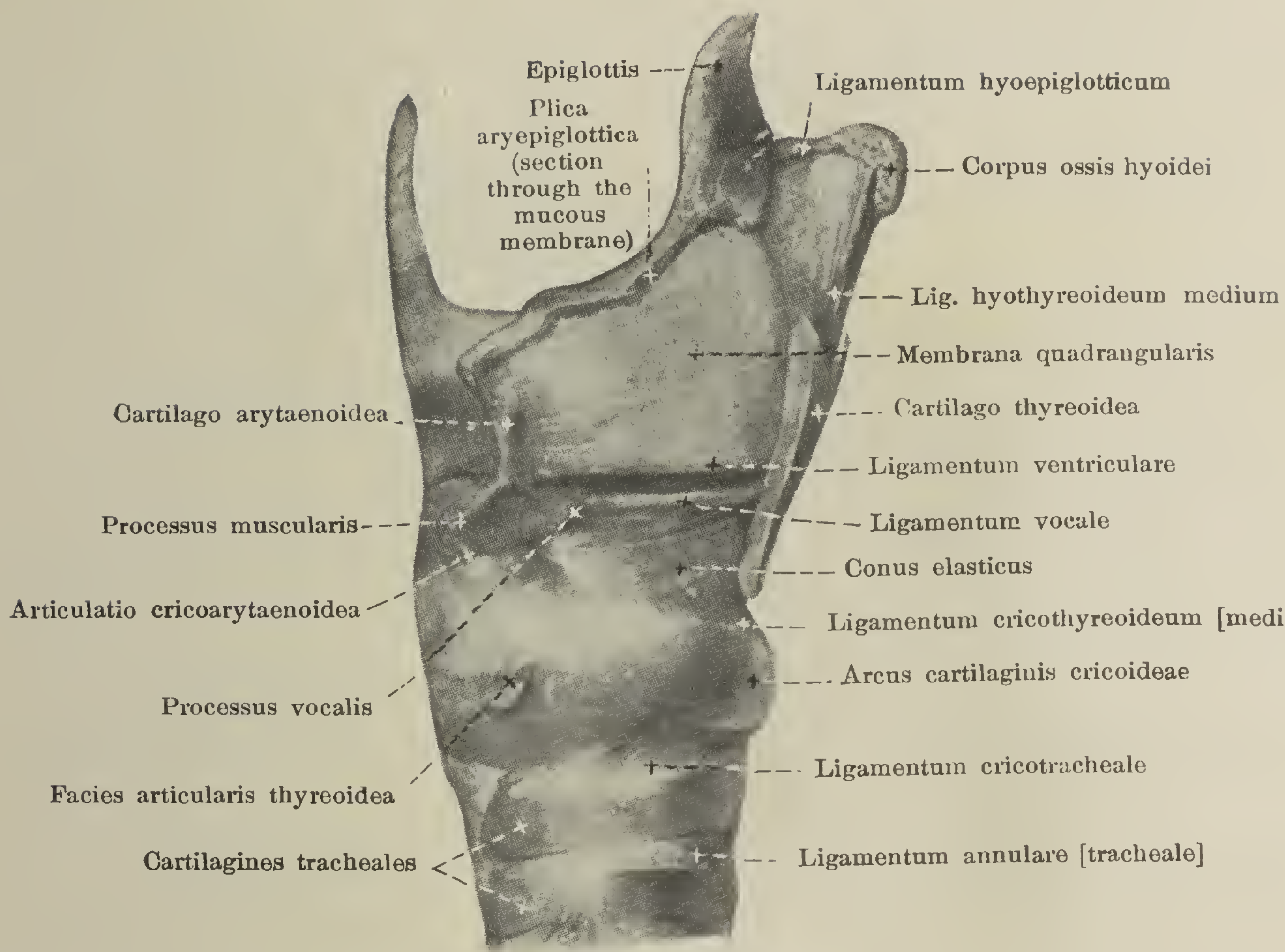
Ligaments and joints of the larynx.

***Membrana hyothyreoidea** (hyothyroid membrane)* (see also Fig. 660) is the name given to the loose membrane of connective tissue, which goes from the posterior margin of the corpus and from the cornua majora ossis hyoidei (bursae, see p. 275) to the upper margin of the thyroid cartilage and divides medianly into an anterior and posterior layer. The anterior layer is strengthened in the middle by elastic fibres which form the *ligamentum hyothyreoideum medium* (see also Fig. 666), is laterally very thin and nearly in the middle of the cornu majus joins the posterior layer (see Fig. 660). The posterior layer arises at the lateral margin of the cartilago epiglottica, connects with the lig. hyoepiglotticum and only laterally attaches to the upper margin of the thyroid cartilage, medianly it goes into the depth behind it. The membrane presents an opening for the passage of the a. and v. laryngea superior and the ramus internus n. laryngei superioris and on its lateral extremity is thickened on each side by means of elastic fibres between the tips of the cornu majus ossis hyoidei and the cornu superius cartilaginis thyreoideae to form a rounded cord, *ligamentum hyothyreoideum laterale* (see also Fig. 660); this usually contains a small piece of fibrocartilage, *cartilago triticea* (not infrequently ossified). Between the two layers the posterior extremity of a fat body is shoved in from in front (see p. 571 and Fig. 660).

In the ***articulatio cricothyreoidea*** on each side the facies articularis thyreoidea of the cricoid cartilage glides upon the cornu inferius of the thyroid cartilage. The *capsula articularis cricothyreoidea* is stretched out between the margins of the articular surfaces; it is very thin and loose. It is strengthened by the *ligamenta ceratocricoidea*, which arise at the cornu inferius of the thyroid cartilage, and of which the *anterius* (see Fig. 651) extends forward and downward, the *laterale* downward, while the *posterius* passes medianward from the inner surface of the cornu inferius to the upper margin of the lamina cartilaginis cricoideae.

In the ***articulatio cricoarytaenoidea*** on each side the facies articularis of the arytaenoid cartilage moves upon the facies articularis arytaenoidea of the cricoid cartilage. The *capsula articularis cricoarytaenoidea* goes off just outside the margins of the articular surfaces; it is very thin and loose. It is strengthened on the posterior surface by the elastic *ligamentum cricoarytaenoideum posterius*, which extends from the upper margin of the lamina cartilaginis cricoideae lateralward to the medial part of the dorsal surface of the arytaenoid cartilage.

Synchondrosis arycorniculata is the name given to the movable union formed by loose connective tissue bands between the cartilago corniculata [Santorini] and the apex cartilaginis arytaenoideae.


Epiglottis
Plica aryepiglottica (section through the mucous membrane)
Ligamentum hyoepiglotticum
Corpus ossis hyoidei
Lig. hyothyreoideum medium
Membrana quadrangularis
Cartilago arytaenoidea
Cartilago thyreoidea
Ligamentum ventriculare
Processus muscularis
Ligamentum vocale
Conus elasticus
Articulatio cricoarytaenoidea
Ligamentum cricothyreoideum [medium]
Arcus cartilaginis cricoideae
Processus vocalis
Facies articularis thyreoidea
Ligamentum cricotracheale
Cartilagines tracheales
Ligamentum annulare [tracheale]

659. Larynx with its ligaments, viewed from the right.

(The right half of the hyoid bone and of the cartilago thyreoidea have been removed.)

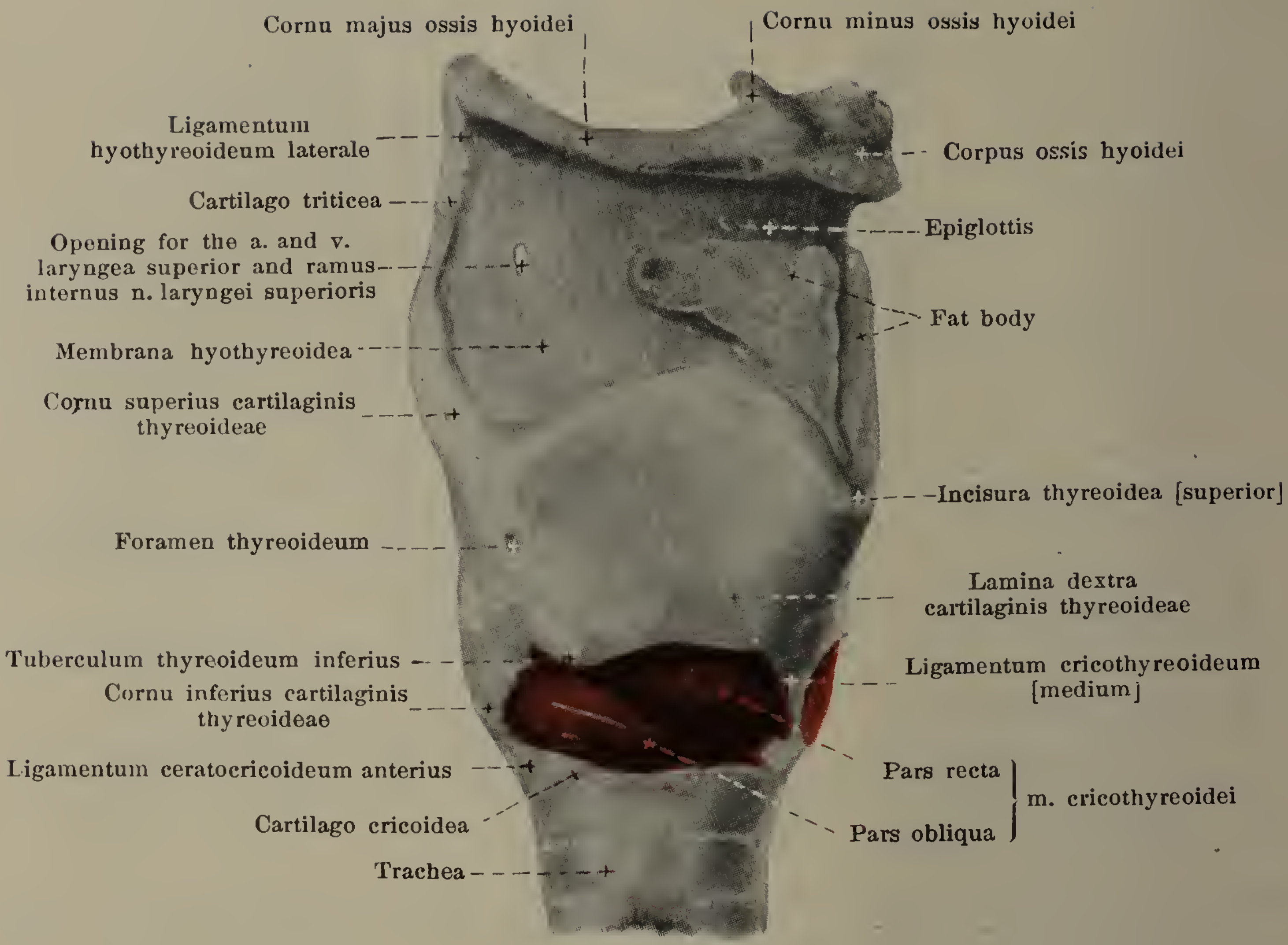
Ligaments and joints of the larynx (continued).

Going downward from the tip of each cartilago corniculata (see Fig. 658) is a thin band of connective tissue, the *ligamentum corniculopharyngeum*, which unites behind the mm. arytaenoidei with that of the other side to form a strip, which extends to the upper margin of the lamina of the cricoid cartilage and to the anterior surface of the mucous membrane of the pharynx; the inferior fibres of this strip are designated the *ligamentum cricopharyngeum* (not illustrated).

The cartilago epiglottica is connected with the other cartilages by loose ligaments only. At the root of the tongue it is fastened by the *ligamentum glossoepiglotticum* (consisting of elastic fibres) (not illustrated), which runs from before backward in the plica glossoepiglottica mediana. The *ligamentum hyoepiglotticum* (see also Fig. 666) extends as a short but broad plate of elastic fibres from the upper margin of the body and the cornua majora of the hyoid bone to the anterior surface of the cartilage of the epiglottis and coalesces laterally with the posterior layer of the membrana hyothyreoidea. The petiolus epiglotticus is fastened behind and below the incisura thyreoidea superior by means of the powerful *ligamentum thyreoepiglotticum* (see Fig. 666) consisting of elastic fibres. The triangular space between the ligamentum hyoepiglotticum, the anterior surface of the cartilage of the epiglottis and the ligamentum hyothyreoideum medium contains on each side a mass of fat (see Figs. 660 and 666), which is shoved in lateral between the two layers of the membrana hyothyreoidea.

The *ligamentum cricotracheale* is the name given to the vertical, short bands of connective tissue which run from the inferior margin of the cricoid cartilage to the superior margin of the first cartilago trachealis.

The ***conus elasticus*** (see also Fig. 668) is a membrane the elastic bands of which radiate fan-like from the lower margin and from the posterior surface of the angle of the cartilago thyreoidea to the upper margin of the arch of the cartilago cricoidea and to the processus vocales of the cartilagines arytaenoideae. The two halves of the membrane converge above and medianward and are slightly concave lateralward. The most anterior thick portion consisting of perpendicular fibres, *ligamentum cricothyreoideum [medium]* (see also Figs. 660, 661 and 666), is stretched out in the middle from the inferior margin of the thyroid cartilage to the upper margin of the arcus cartilaginis cricoideae; it is perforated by vessels and becomes broader below. The uppermost strengthened bands of fibres of the conus arise on each side as the *ligamentum vocale* (see also Figs. 663, 667 and 668) close to the median plane from the middle of the angle of the cartilago thyreoidea and run horizontally to the processus vocalis. They surround in front a small nodule of elastic tissue which may contain cartilage cells, *cartilago sesamoidea* (not illustrated).


Cornu majus ossis hyoidei
Cornu minus ossis hyoidei
Ligamentum hyothyreoideum laterale
Corpus ossis hyoidei
Cartilago triticea
Epiglottis
Opening for the a. and v. laryngea superior and ramus internus n. laryngei superioris
Fat body
Membrana hyothyreoidea
Cornu superius cartilaginis thyreoideae
Incisura thyreoidea [superior]
Foramen thyreoideum
Lamina dextra cartilaginis thyreoideae
Tuberculum thyreoideum inferius
Ligamentum cricothyreoideum [medium]
Cornu inferius cartilaginis thyreoideae
Ligamentum ceratocricoideum anterius
Pars recta
m. cricothyreoidei
Cartilago cricoidea
Pars obliqua
Trachea

660. Larynx with its muscles, viewed from the right.
(The anterior layer of the membrana hyothyreoidea [with the lig. hyothyreoideum medium] has been removed.)

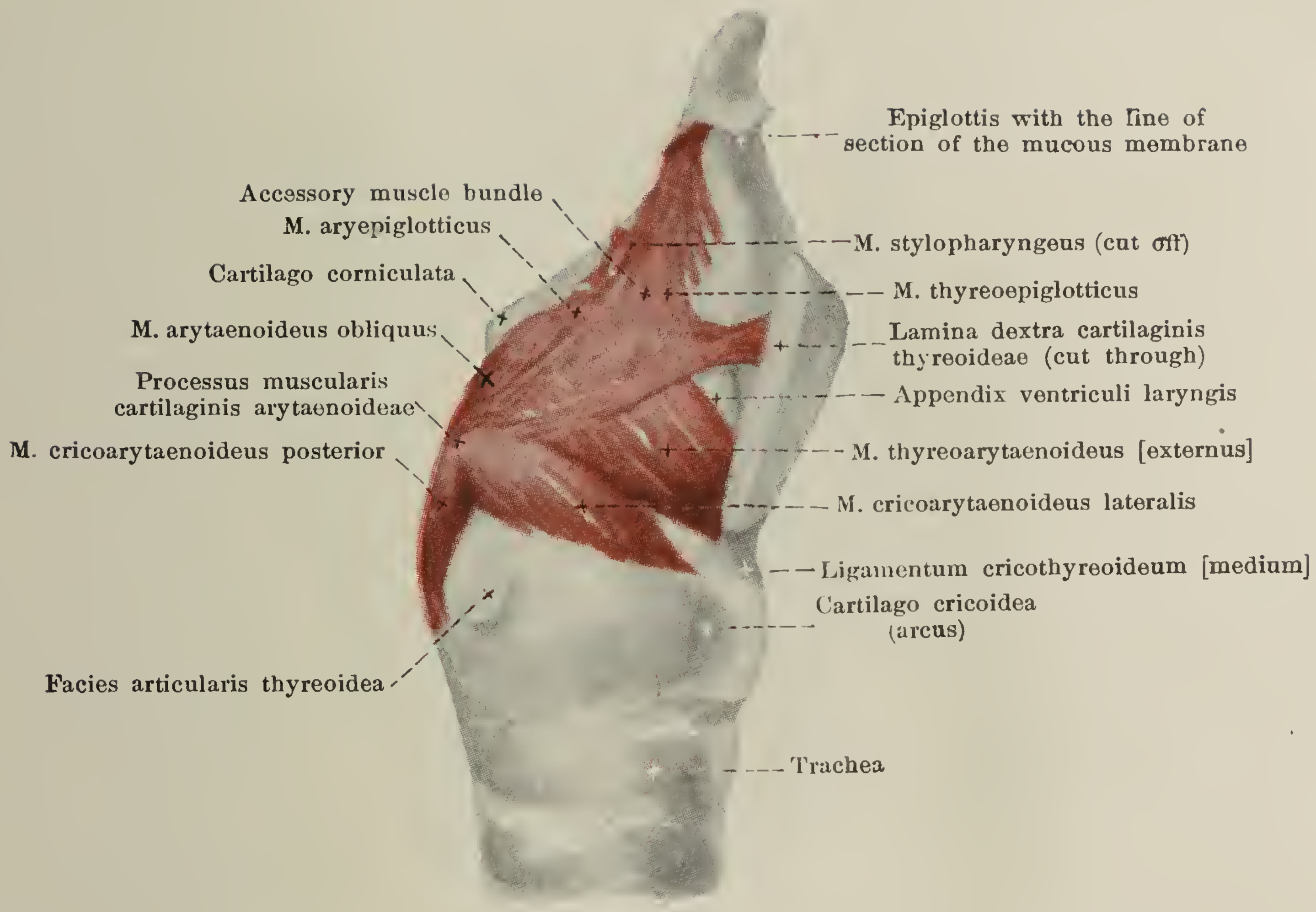
Ligaments and joints of the larynx (continued).

Membrana quadrangularis (see Fig. 659) is a membrane somewhat split up by glands deposited in it; it consists of elastic fibres the bundles of which run in sagittal direction in the main horizontally, partly also backward and downward. It arises on each side in front and above at the lateral margin of the cartilago epiglottica, below at the posterior surface of the angle of the cartilago thyreoidea and becomes attached behind the cartilago corniculata [Santorini] and to the medial margin of the arytaenoid cartilage. The membranes of the two sides converge below and medianward. The inferior end is called the ***ligamentum ventriculare*** and consists of fibres which go off at the thyroid cartilage somewhat above the ligamentum vocale and extend horizontally near the median plane backward to the medial margin of the fovea triangularis of the arytaenoid cartilage. Its upper margin runs obliquely backward, downward and medianward. The membrane above forms the basis of the plica aryepiglottica and there contains posteriorly the cartilago cuneiformis [Wrisbergi].

Conus elasticus and membranae quadrangulares are grouped together as ***membrana elastica laryngis.***

Muscles of the larynx *(musculi laryngis).*

M. cricothyreoideus (see also Figs. 349, 353, 576 and 668), paired. Form: quadrangular, broader and thicker above. Position: on the external surface of the larynx, covered by the glandula thyreoidea, as well as by the mm. sternothyreoideus and sternohyoideus. Those of the two sides leave free between them in the middle a triangular area broader above, in which the ligamentum cricothyreoideum [medium] is visible. Origin: inferior margin and medial surface of the lamina cartilaginis thyreoideae as far as the apex of the cornu inferius. Insertion: external surface of the arcus cartilaginis cricoideae. The fibres converge downward like a fan so that in the anterior portion, *pars recta*, they extend more vertically, in the posterior portion, *pars obliqua*, more obliquely forward; the two portions are often distinctly separated from one another. Behind, the muscle is usually covered by bundles of origin of the m. cricopharyngeus (see p. 527) and is connected with them. Action: the muscles of both sides elevate the arcus, move the upper margin of the lamina of the cricoid cartilage (and the cartilagines arytaenoideae) dorsalward and thereby make the ligamenta vocalia tense. Innervation: ramus externus n. laryngei superioris (X).


Epiglottis with the line of section of the mucous membrane
Accessory muscle bundle
M. aryepiglotticus
M. stylopharyngeus (cut off)
Cartilago corniculata
M. thyreoepiglotticus
M. arytaenoideus obliquus
Lamina dextra cartilaginis thyreoideae (cut through)
Processus muscularis cartilaginis arytaenoideae
Appendix ventriculi laryngis
M. cricoarytaenoideus posterior
M. thyreoarytaenoideus [externus]
M. cricoarytaenoideus lateralis
Ligamentum cricothyreoideum [medium]
Cartilago cricoidea (arcus)
Facies articularis thyreoidea
Trachea

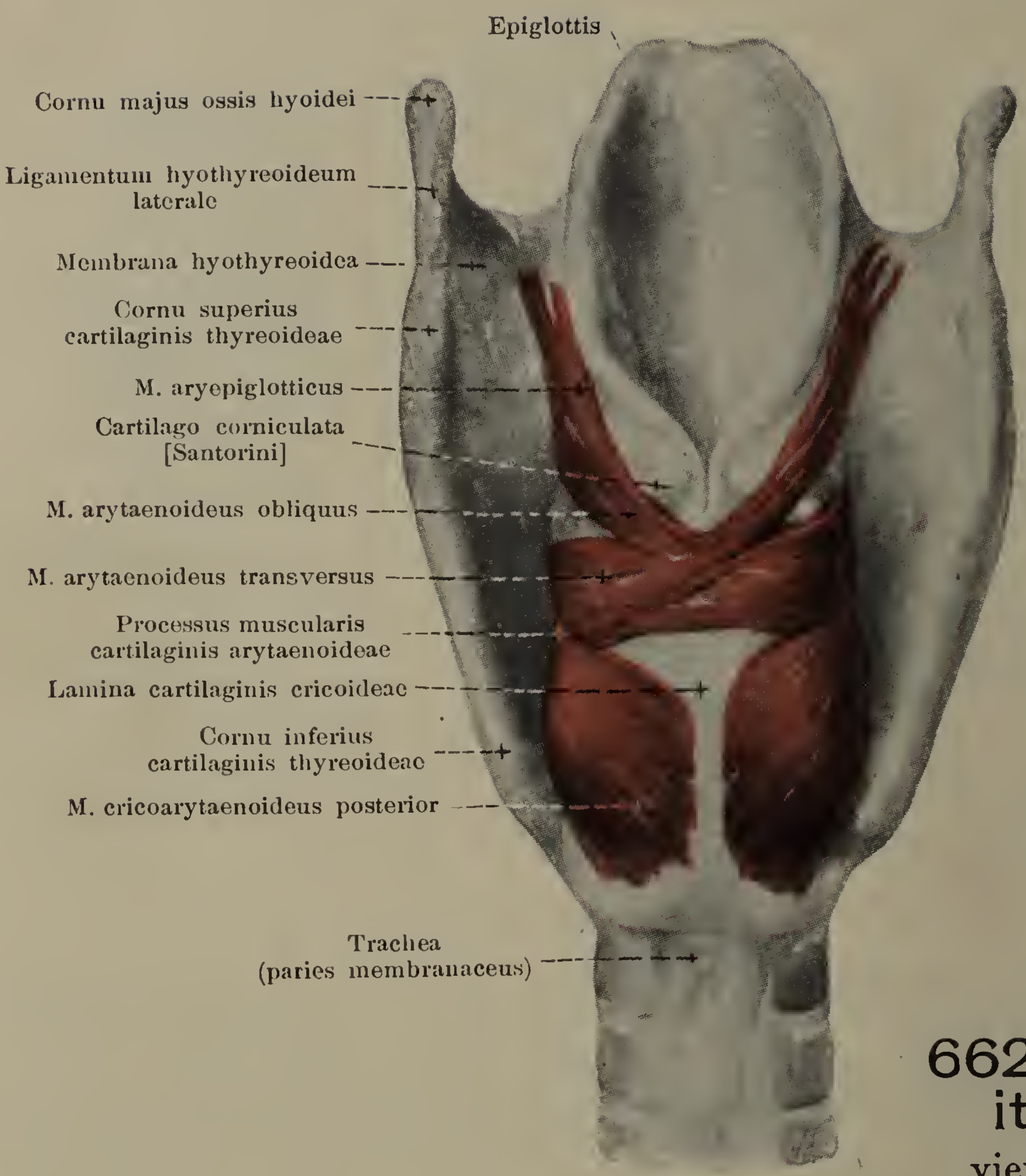
661. Internal muscles of the larynx, viewed from the right.

(The lamina dextra of the cartilago thyreoidea has been removed.)

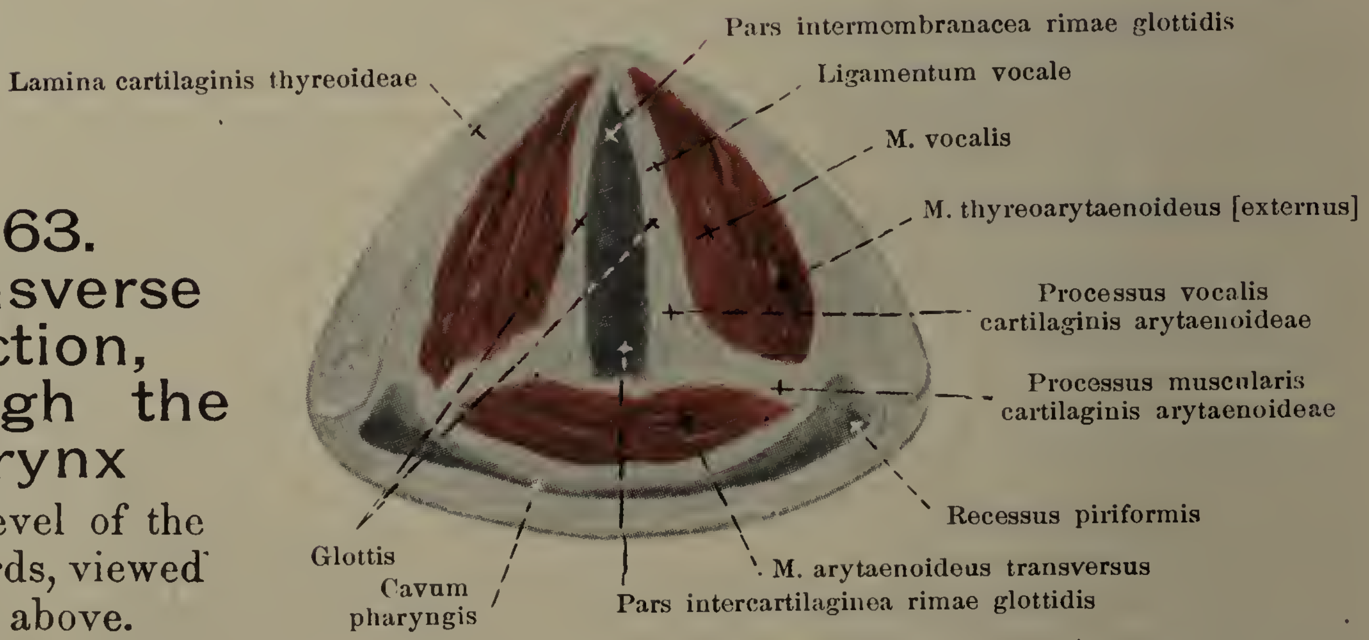
M. cricoarytaenoideus posterior (see also Figs. 602 and 662), paired. Form: triangular. Position: on the posterior surface of the lamina cartilaginis cricoideae, directly covered behind by the tela submucosa of the pharynx. Origin: medial and inferior part of the posterior surface of the lamina cartilaginis cricoideae. Insertion: the fibres converge upward and lateralward to the posterior surface and to the apex of the processus muscularis cartilaginis arytaenoideae; in their course the lateral fibres run nearly vertically, the upper fibres almost horizontally. Action: it draws the processus muscularis backward and downward, rotates the arytaenoid cartilage so that the processus vocalis is turned lateralward and somewhat upward, the rima is opened wider and the ligamentum vocale is put somewhat upon the stretch. Innervation: ramus posterior n. laryngei inferioris (X).

M. cricoarytaenoideus lateralis, paired. Form: triangular. Position: in the lateral wall of the larynx upon the conus elasticus, covered by the lamina cartilaginis thyreoideae, the glandula thyreoidea and the mm. sternothyreoideus, thyreohyoideus, sternohyoideus and thyreopharyngeus. Origin: upper margin and external surface of the arcus cartilaginis cricoideae, as well as the conus elasticus. Insertion: by converging fibres backward and upward to the anterior surface of the processus muscularis cartilaginis arytaenoideae. The muscle is very frequently inseparable from the m. thyreoarytaenoideus [externus]. Action: it draws the processus muscularis forward and downward so that the processus vocalis is turned medianward and a trifle downward, the rima is narrowed and the ligamentum vocale is rendered somewhat flaccid. Innervation: ramus anterior n. laryngei inferioris (X).

M. thyreoarytaenoideus [externus] (see also Figs. 663, 667 and 668), paired, forms with the m. vocalis a common mass of muscle, separable only by artificial means. Form: thin, quadrangular. Position: in the lateral wall of the larynx; medianward it is adjacent above to the appendix ventriculi laryngis, below to the m. vocalis and partly to the conus elasticus; lateralward it is covered by the lamina cartilaginis thyreoideae and the mm. thyreohyoideus and sternohyoideus. Origin: posterior surface of the cartilago thyreoidea, directly lateralward from the m. vocalis, reaching for a variable distance upward. Insertion: the fibres extend backward and upward to the lateral margin of the arytaenoid cartilage; some bundles go over into the m. arytaenoideus obliquus. The upper fibres vary greatly in their development. Action: it draws the cartilago arytaenoidea forward and rotates it, so that the processus vocalis is turned medianward and somewhat downward, the rima is narrowed and the ligamentum vocale is rendered somewhat flaccid. Innervation: ramus anterior n. laryngei inferioris (X).


Epiglottis
Cornu majus ossis hyoidei
Ligamentum hyothyreoideum laterale
Membrana hyothyreoidea
Cornu superius cartilaginis thyreoideae
M. aryepiglotticus
Cartilago corniculata [Santorini]
M. arytaenoideus obliquus
M. arytaenoideus transversus
Processus muscularis cartilaginis arytaenoideae
Lamina cartilaginis cricoideae
Cornu inferius cartilaginis thyreoideae
M. cricoarytaenoideus posterior
Trachea (paries membranaceus)

662. Larynx with its muscles, viewed from behind.


Pars intermembranacea rimae glottidis
Lamina cartilaginis thyreoideae
Ligamentum vocale
M. vocalis
M. thyreoarytaenoideus [externus]
Processus vocalis cartilaginis arytaenoideae
Processus muscularis cartilaginis arytaenoideae
Recessus piriformis
Glottis
Cavum pharyngis
M. arytaenoideus transversus
Pars intercartilaginea rimae glottidis

663. Transverse section, through the larynx at the level of the vocal cords, viewed from above.

M. vocalis (see also Figs. 667 and 668), paired, forms with the m. thyreoarytenoideus [externus] one mass of muscle, which can be separated only by dissection. Form: triangularly prismatic. Position in the labium vocale, its median surface lies directly next to the ligamentum vocale and conus elasticus, its upper surface runs along under the upper surface of the labium vocale, and its lateral surface is bounded by the m. thyreoarytaenoideus [externus] (see p. 573). Origin: lower half of the posterior surface of the angle of the cartilago thyreoidea. Insertion: the fibres run parallel and horizontally backward to the processus vocalis and the fovea oblonga of the cartilago arytaenoidea. Action: it draws the processus vocalis forward, and relaxes the ligamentum vocale. Innervation: ramus anterior n. laryngei inferioris (X).

M. ventricularis (see Fig. 668) consists of several bundles of muscle, visible under the microscope, which run between the glands in the plica ventricularis in a sagittal direction from the lateral edge of the arytaenoid cartilage to the lateral margin of the cartilage of the epiglottis. In addition the pocket ligament contains also outrunners of the mm. thyreoarytaenoideus [externus] and aryepiglotticus.

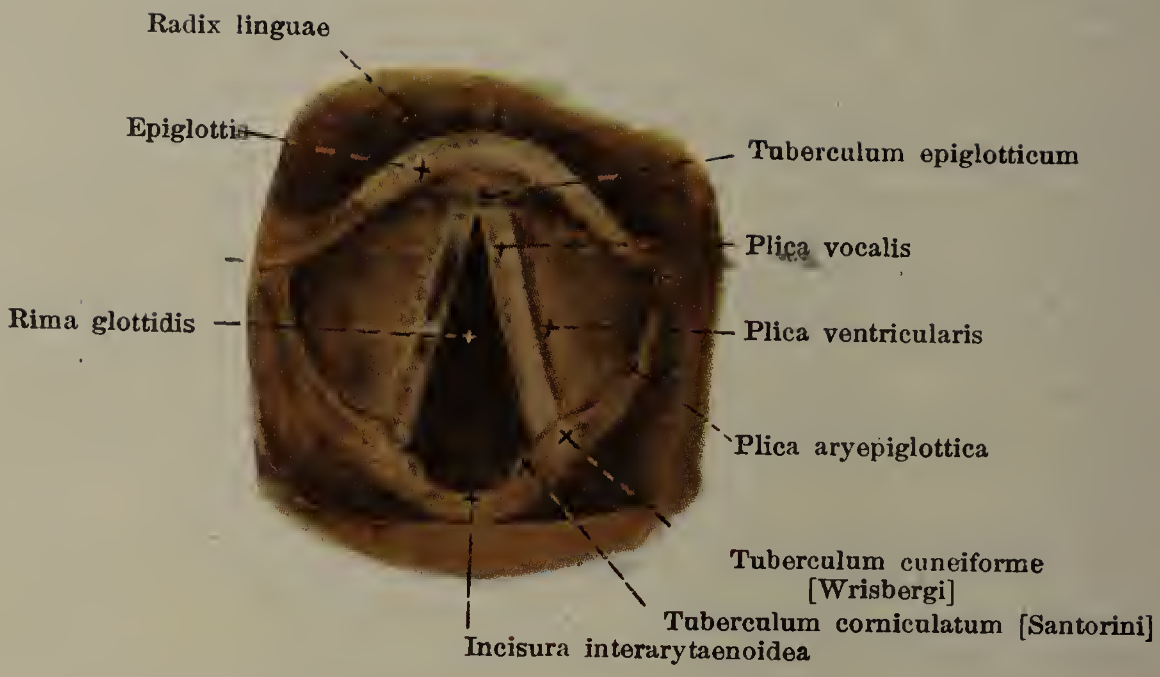
M. thyreoepiglotticus (see Fig. 661), paired and very variable. Form: oblong, thin. Position: in the lateral wall of the larynx; it is bounded below directly by the m. thyreoarytaenoideus [externus], medianward and below lies adjacent to the appendix ventriculi laryngis, above to the membrana quadrangularis and is covered lateralward by the lamina cartilaginis thyreoideae and by the mm. sternothyreoideus and sternohyoideus. Origin: medial surface of the lamina cartilaginis thyreoideae, immediately adjacent to the m. thyreoarytaenoideus [externus]. Insertion: the fibres run in arches upward and backward partly toward the margin of the plica aryepiglottica, partly toward the margin of the cartilago epiglottica, interwoven with the m. aryepiglotticus. Action: it widens the aditus and the vestibulum laryngis. Innervation: ramus anterior n. laryngei inferioris (X).

M. arytaenoideus obliquus (see Figs. 661 and 662), paired. Form: narrow, thin. Position: in the posterior wall of the larynx, bounded in front by the m. arytaenoideus transversus, covered behind by the tela submucosa pharyngis. Origin: posterior surface of the processus muscularis cartilaginis arytaenoideae. Insertion: the fibres run obliquely medianward and upward, decussate in the median plane with those of the other side, arrive at the tip of the arytaenoid cartilage of the other side, and there become partially attached; a part of them, arising there ***(m. aryepiglotticus),*** extend forward and upward in arches in the plica aryepiglottica to terminate in the membrana quadrangularis and at the lateral margin of the cartilago epiglottica. Above, it is connected with fibres of the m. stylopharyngeus (see p. 527). Action: it narrows the aditus and the vestibulum laryngis. Innervation: ramus anterior n. laryngei inferioris (X).

M. arytaenoideus transversus (see also Figs. 662, 663 and 666), unpaired. Form: oblong-quadrangular, thick. Position: in the posterior wall of the larynx; its anterior surface is adjacent to the posterior concave surface of the arytaenoid cartilage and between them is covered by the mucous membrane of the larynx; its posterior surface is covered by the mm. arytaenoidei obliqui and by the tela submucosa pharyngis. It reaches below as far as the lamina cartilaginis cricoideae, above not quite as far as the apex of the arytaenoid cartilages. Origin and insertion: on both sides to the posterior surface of the processus muscularis and to the lateral edge of the cartilago arytaenoidea. The fibres run horizontally in a frontal direction. Action: it draws the processus musculares backward and upward so that the processus vocales approach one another and are somewhat elevated, the rima is narrowed, and the ligamenta vocalia are put somewhat upon the stretch. Innervation: ramus posterior n. laryngei inferioris (X) of both sides.

Cavum laryngis *(cavity of the larynx)*, (see Figs. 663—668).

The cavity of the larynx is considerably smaller than its outer circumference. It is bounded in front (see Fig. 666) by the posterior surface of the cartilago epiglottica, of the ligamentum thyreoepiglotticum, of the angle of the cartilago thyreoidea, of the ligamentum cricothyreoideum [medium] and of the arcus cartilaginis cricoideae. The lateral wall (see Figs. 666 and 667) is formed on each side by the medial surface of the membrana quadrangularis with the cartilagines cuneiformis [Wrisbergi] et corniculata [Santorini], of the cartilago arytaenoidea, of the conus elasticus and of the arcus cartilaginis cricoideae. The posterior wall (see Fig. 666) is closed by the anterior surface of the m. arytaenoideus transversus and the lamina cartilaginis cricoideae. These walls are all directly covered by the *mucous membrane of the larynx, tunica mucosa laryngis.* It is connected at the *epiglottis* with the mucous membrane of the tongue. At the upper margin of the membrana quadrangularis it is continuous on each side with the tunica mucosa pharyngis and it forms a fold with the latter, *plica aryepiglottica* (see Figs. 664—666), which extends medianward, downward and backward from the lateral margin of the epiglottis to the apex of the arytaenoid cartilage, and which contains processes of the mm. stylopharyngeus, thyreoepiglotticus and aryepiglotticus. This fold in the neighborhood of its posterior end presents two small nodules, an anterior, *tuberculum cuneiforme [Wrisbergi]*, and a posterior, *tuberculum corniculatum [Santorini]*, which are due to the projections of the cartilages of the same name. The anterior wall is broad above (see Fig. 665) and becomes very markedly narrow toward the middle, widening out again below; it presents just above the middle a small transverse projection, *tuberculum epiglotticum* (see Figs. 664 and 665), which covers the petiolus epiglottidis and the ligamentum thyreoepiglotticum. The lateral surface (see Fig. 666) presents above a projection which extends obliquely downward and forward from the tuberculum cuneiforme; this projection contains the cartilago cuneiformis and the glandulae laryngeae mediae. Just below, running horizontally in a sagittal direction, are two folds, *plica ventricularis* and *plica vocalis* (see Figs. 664—668), separated from one another by a deep groove, *ventriculus laryngis [Morgagnii].*



664. Laryngoscopic view of the larynx

on, quiet breathing (after M. Schmidt).

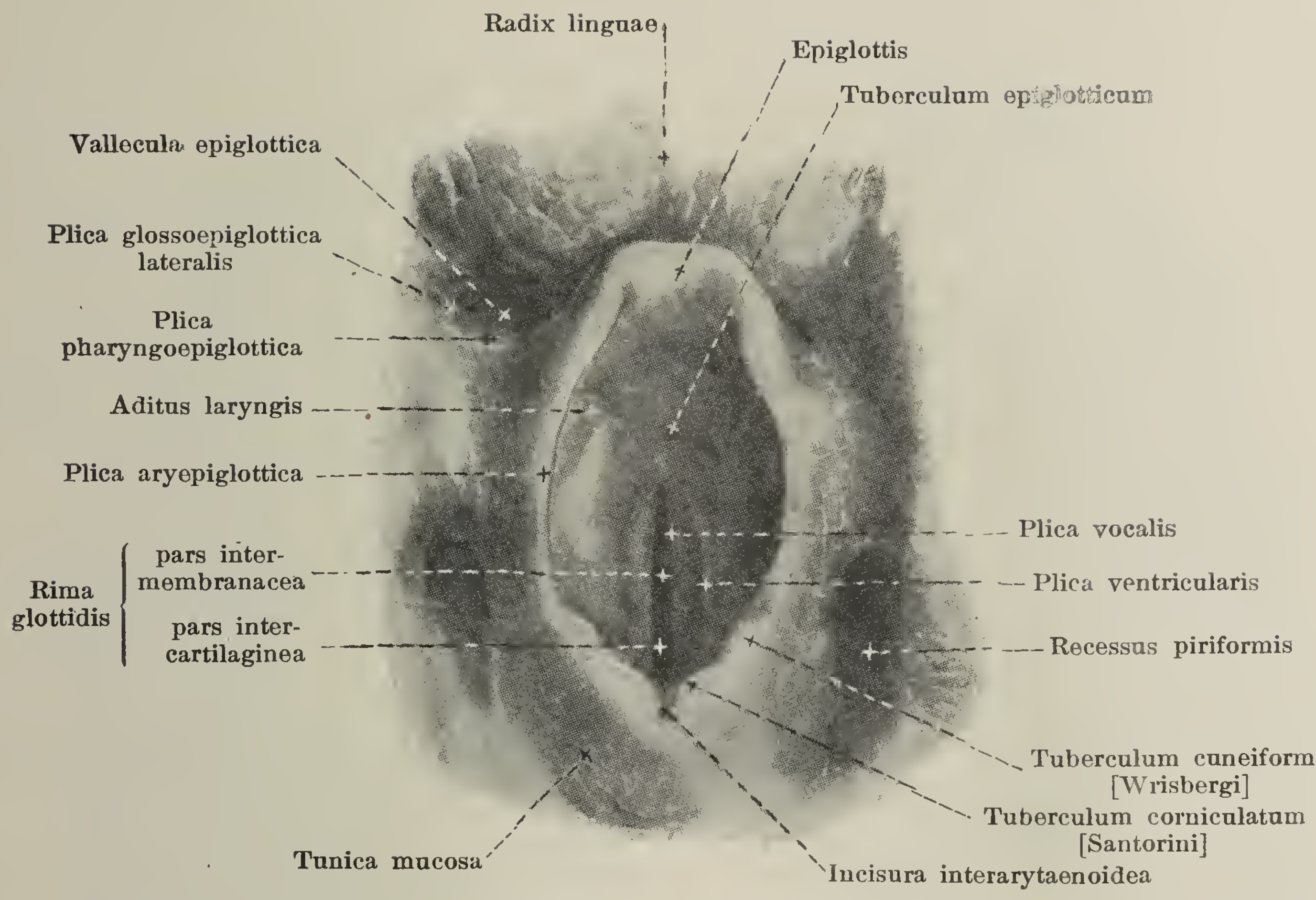
Cavum laryngis (see Figs. 663—668) (continued).

The upper fold, ***plica ventricularis,*** *ventricular fold* (O. T. false vocal cord), presents a projecting free margin and forms by its broad inferior surface the upper wall of the ventriculus laryngis; its insertions are the same as those of the ligamentum ventriculare (see p. 527). It contains within it the lower part of the membrana quadrangularis with the ligamentum ventriculare, the m. ventricularis and the glandulae laryngeae mediae.

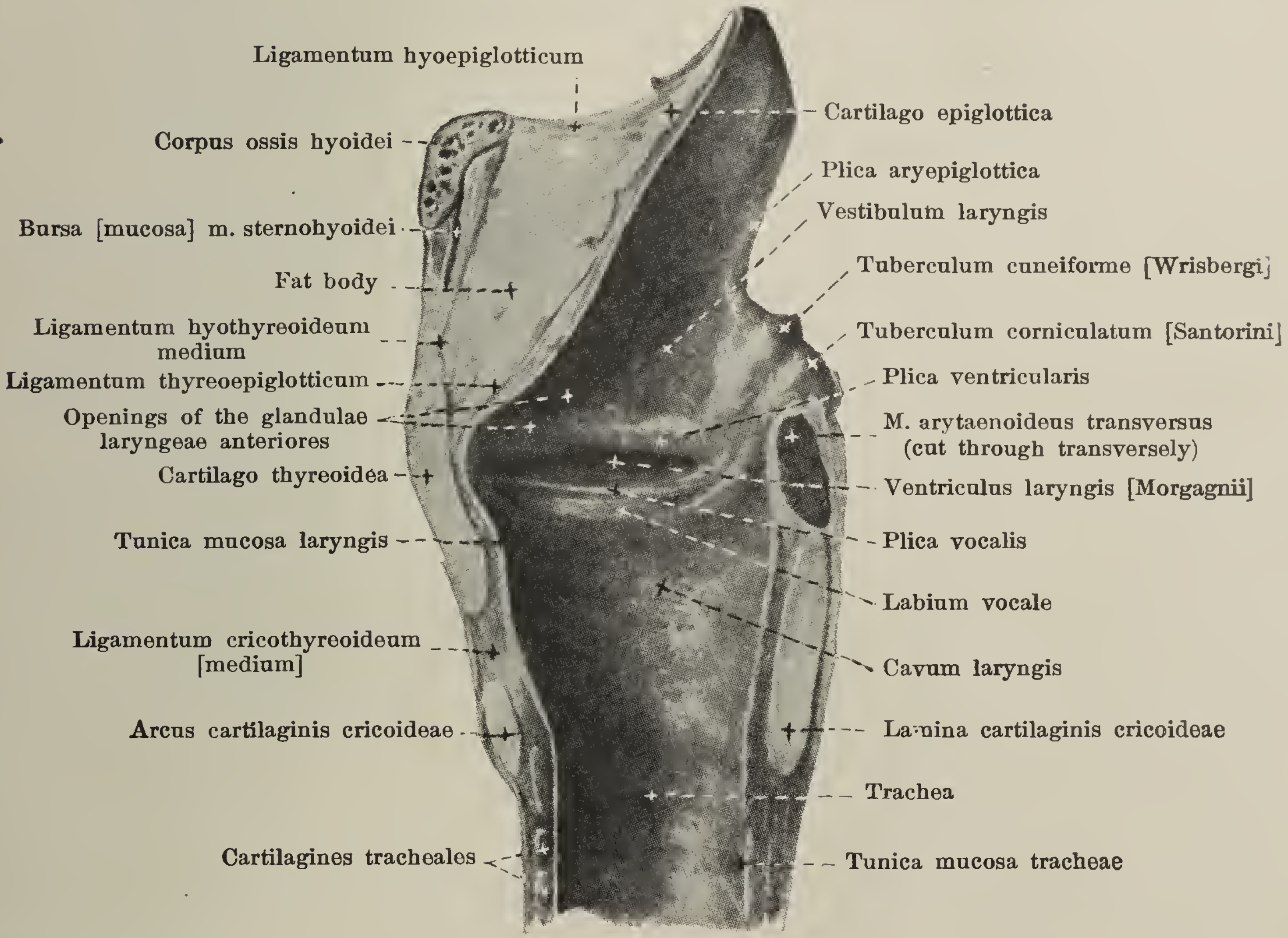
The lower fold, ***plica vocalis,*** *vocal fold* (O. T. true vocal cord), is the free margin of the trilateral-prismatic projection, *labium vocale,* the upper free surface of which is horizontal, flat or a little concave and forms the inferior wall of the ventriculus laryngis, while its medial, free surface is turned at the same time downward; the projection contains within it the upper part of the conus elasticus with the ligamentum vocale, as well as the m. vocalis. The vocal fold projects farther medianward than the ventricular fold. It presents a tolerably sharp, free edge which has the same attachment as the ligamentum vocale; near the anterior end the cartilago sesamoidea shows through the mucous membrane as a yellowish spot *(macula flava).* The tone-producing apparatus formed by the two vocal folds is called the *glottis.*

The ***ventriculus laryngis [Morgagnii]*** is a long drawn out pocket-shaped slit which extends lateralward between the ventricular fold and the vocal fold and is deepest in the middle. It gives off usually from its anterior half vertically upward a very variable slit-like blind sack, *appendix ventriculi laryngis,* which is shoved in upward between the ventricular fold on one hand, the m. thyreoarytaenoideus [externus] and the lamina cartilaginis thyreoideae on the other (see also Fig. 661) and usually ends beneath the upper margin of the latter; its anterior margin is bounded by the epiglottis; its walls are folded. Very rearely the appendix is absent, or it may be enlarged. In the new-born it is larger than in the adult.

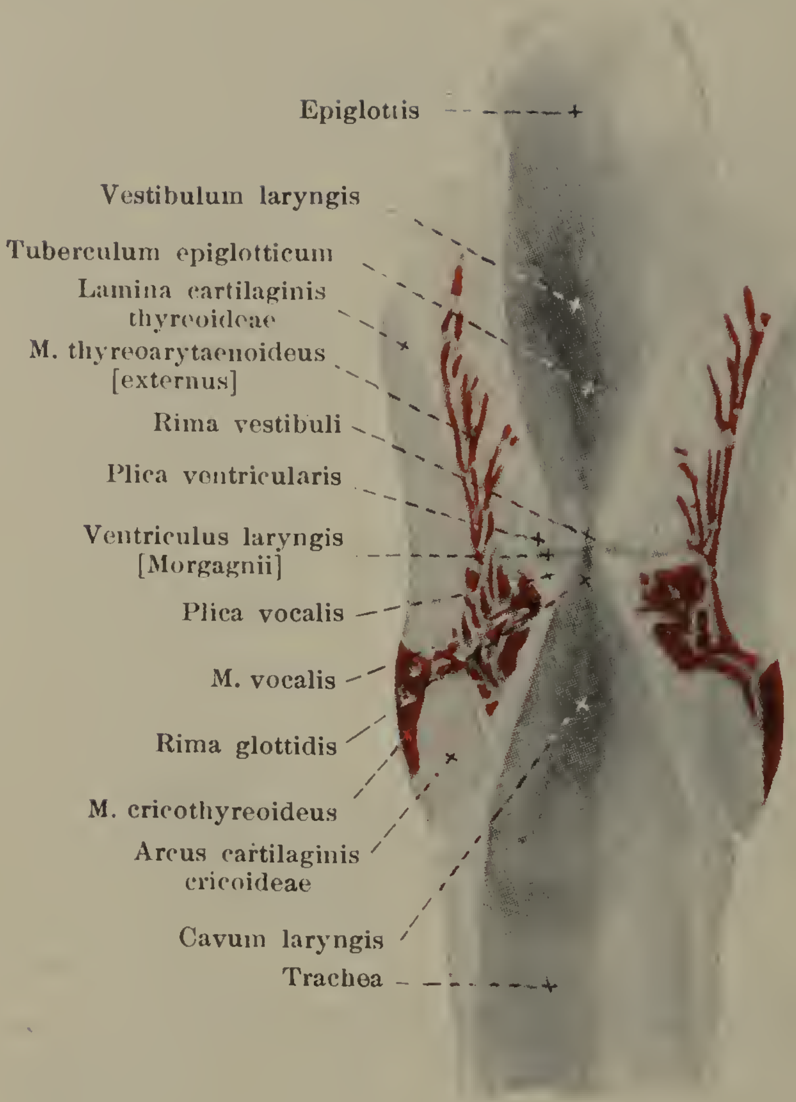
The upper opening of the larynx, *aditus laryngis* (see Fig. 665), looks backward and upward and is triangular and rounded. It is bounded by the posterior surface of the epiglottis and by the plicae aryepiglotticae converging backward; passing for a short distance downward between the cartilagines corniculatae is a small slit, the *incisura interarytaenoidea.* The upper approximately oval part of the cavity, *vestibulum laryngis* (see Figs. 665—667) is higher in front than behind, becomes narrower passing downward and goes over through the *rima vestibuli* (bounded by the two ventricular folds) into the *aditus glottidis superior,* which is bounded lateralward by the ventriculi laryngis. Just beneath it at the level of the 5th cervical vertebra, between the two plicae vocales, lies the *rima glottidis* (see Figs. 663, 665 and 667), the form of which is approximately lancet-shaped in the cadaver, but in life is very variable. In it can be distinguished a longer, anterior portion situated between the plicae vocales and called the *pars intermembranacea,* and a shorter posterior portion, bounded lateralward by the medial surfaces of the arytaenoid cartilages, behind by the anterior surface of the m. arytaenoideus transversus, and called the *pars intercartilaginea.* The space situated just beneath the rima glottidis, the *aditus glottidis inferior,* is oval in cross-section; where it goes over into the trachea, it is round.



665. Cavity of the larynx, viewed from above.


Ligamentum hyoepiglotticum
Corpus ossis hyoidei
Bursa [mucosa] m. sternohyoidei
Fat body
Ligamentum hyothyreoideum medium
Ligamentum thyreoepiglotticum
Openings of the glandulae laryngeae anteriores
Cartilago thyreoidea
Tunica mucosa laryngis
Ligamentum cricothyreoideum [medium]
Arcus cartilaginis cricoideae
Cartilagines tracheales
Cartilago epiglottica
Plica aryepiglottica
Vestibulum laryngis
Tuberculum cuneiforme [Wrisbergi]
Tuberculum corniculatum [Santorini]
Plica ventricularis
M. arytaenoideus transversus (cut through transversely)
Ventriculus laryngis [Morgagnii]
Plica vocalis
Labium vocale
Cavum laryngis
Lamina cartilaginis cricoideae
Trachea
Tunica mucosa tracheae

666. Median section of the larynx,
right half, viewed from the left.

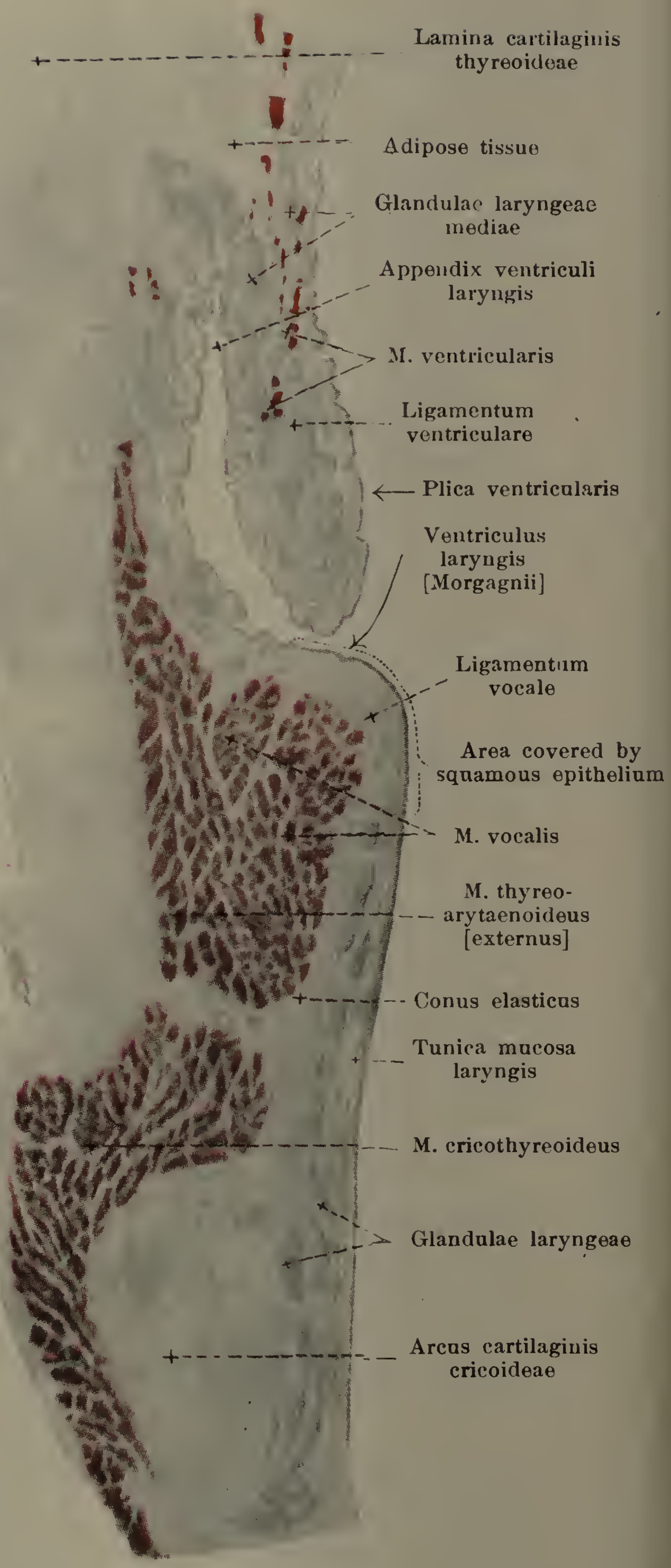


667. Frontal section of the larynx,

anterior half, viewed from behind.

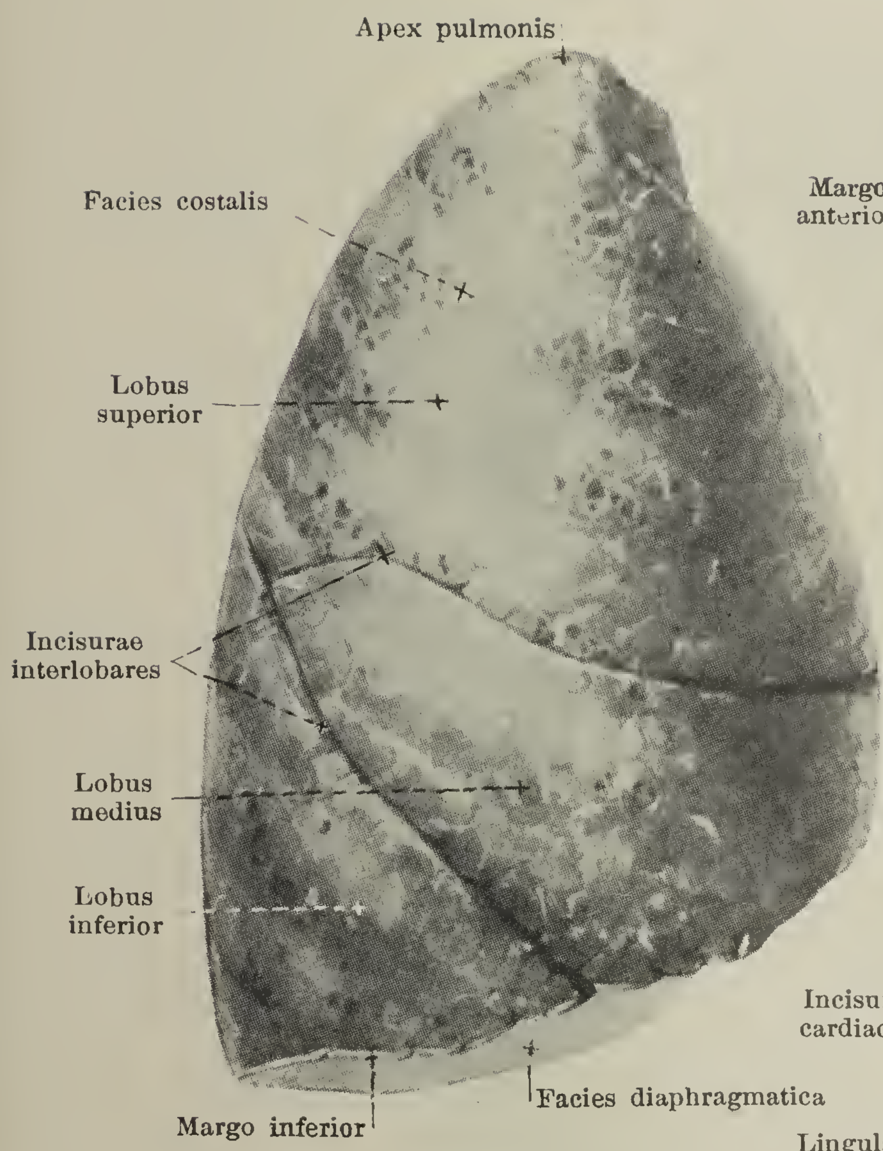
(The section passes through the posterior portion of the vocal fold.)

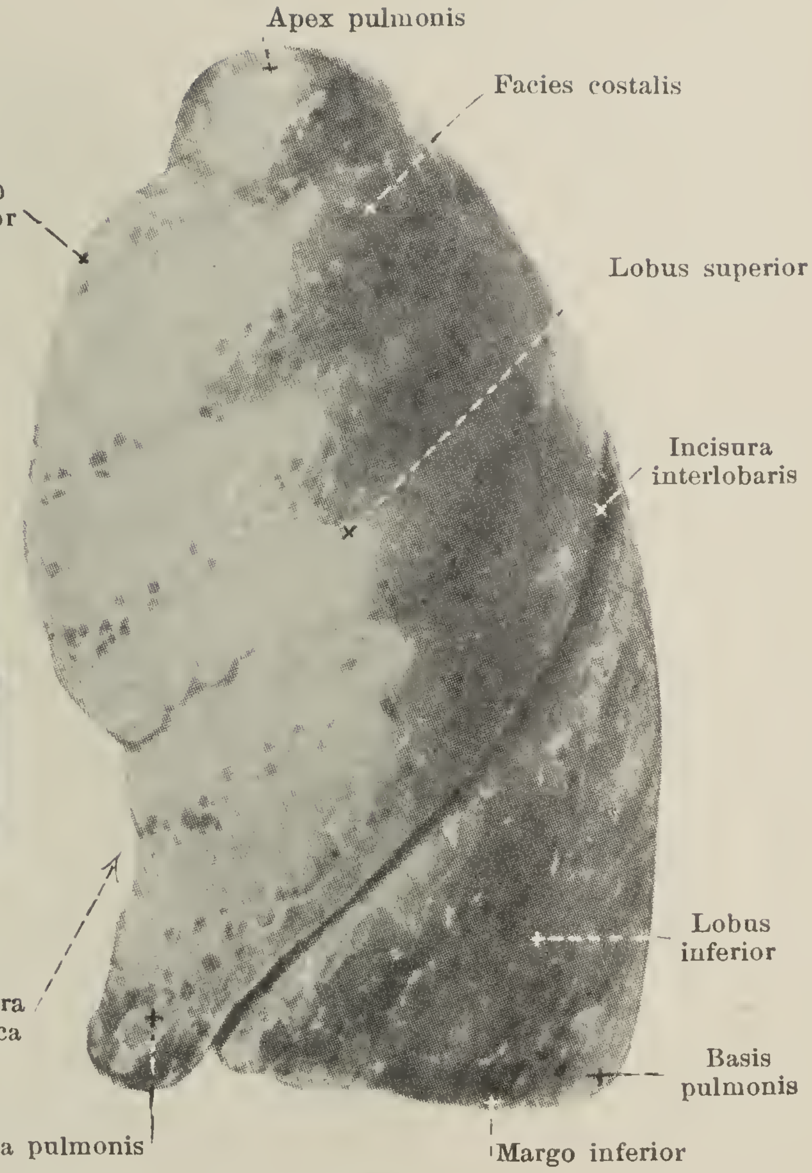
The *mucous membrane of the larynx* is of a reddish color, that of the vocal folds of a white color; it is firmly connected with the underlying tissue on the posterior surface of the epiglottis and on the ventricular and vocal folds, elsewhere more loosely. It contains lymph nodules, *noduli lymphatici laryngei,* on the posterior surface of the epiglottis and in the ventriculus laryngis; also numerous glands, *glandulae laryngeae.* The latter are found in larger groups in front of and behind the epiglottis, *gl. laryngeae anteriores* (see Fig. 666); in the ventricular fold, as a sheath for the cartilago cuneiformis, in the fovea triangularis of the arytaenoid cartilage and in the ventriculus laryngis, *gl. laryngeae mediae;* as well as before, within and behind the m. arytaenoideus transversus, *gl. laryngeae posteriores.* The glands are entirely absent from the vocal folds.


Lamina cartilaginis thyreoideae
Adipose tissue
Glandulae laryngeae mediae
Appendix ventriculi laryngis
M. ventricularis
Ligamentum ventriculare
Plica ventricularis
Ventriculus laryngis [Morgagnii]
Ligamentum vocale
Area covered by squamous epithelium
M. vocalis
M. thyreo-arytaenoideus [externus]
Conus elasticus
Tunica mucosa laryngis
M. cricothyreoideus
Glandulae laryngeae
Arcus cartilaginis cricoideae

668. Frontal section through the anterior part of the larynx.

Magnification: 5 : 1.



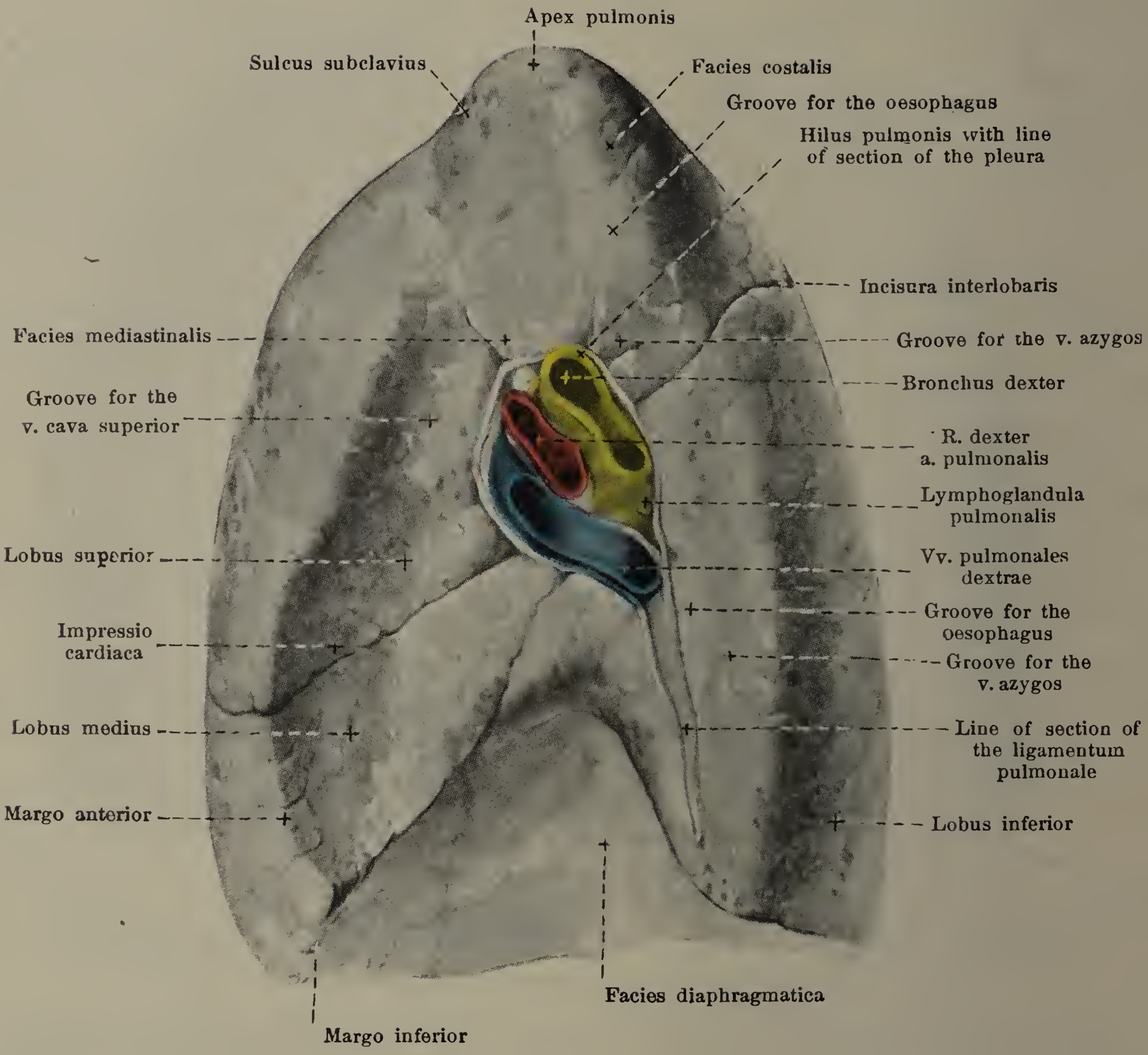


669. Right lung, 670. Left lung;

viewed from in front and lateralward.

The **trachea** (see Figs. 358, 563, 567, 606, 607, 658, 659, 666, 675, 680 and 682) is a cylindrical, hollow, elastic tube. It begins above as the continuation of the larynx in front of the 7th cervical vertebra, passes downward and somewhat backward and divides *(bifurcatio tracheae)* in front of the 4th or 5th thoracic vertebral body, at the level of the processus spinosus of the 4th thoracic vertebra or somewhat below this point, into the two *bronchi;* as it descends it is more deeply situated, lies in the median plane and below only deviates a little to the right. Its posterior wall adjoins the oesophagus. In front it is covered in the neck by the isthmus glandulae thyreoideae and by the v. thyreoidea ima, in the thoracic cavity by the a. anonyma, a. carotis communis sinistra, arcus aortae, v. anonyma sinistra and by the thymus gland situated in front of them. Its lateral surfaces lie in the neck in contact with the lobi glandulae thyreoideae and the nn. recurrentes (X), in the thoracic cavity on the right side with the n. vagus dexter, the v. azygos and the pleura mediastinalis, on the left side with the n. recurrens sinister (X) and the arcus aortae. It is ensheathed in loose connective tissue, which contains especially on the anterior surface numerous lymph nodules, *lymphoglandulae tracheales;* especially constant is a large group of lymph glands beneath the angle of bifurcation, *lymphoglandulae bronchiales.* The cross-section of the trachea is rounded with its posterior wall flattened. The lumen enlarges from above toward the middle and then again diminishes in size.

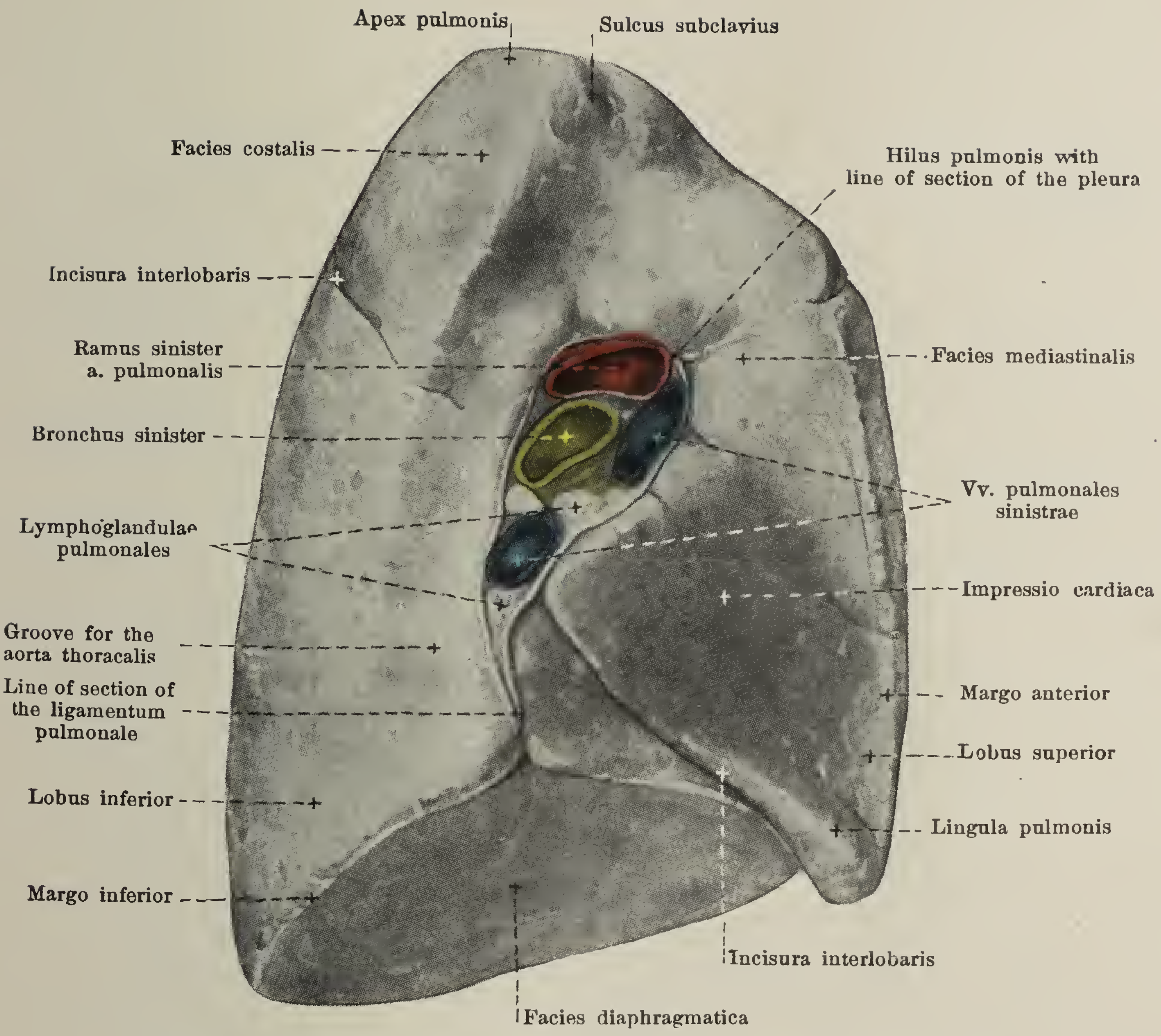
The wall of the trachea contains 16—20 horseshoe-like curved strips of hyaline cartilage, open behind, the *cartilagines tracheales.* They are often split and may be united with their neighbors. The strips of cartilage are connected with one another by means of the *ligamenta annularia [trachealia]*, tough membranes, consisting chiefly of elastic and collagenous fibres running longitudinally; these membranes are continous with the perichondrium, and with a similarly built but thinner layer of the posterior wall. The posterior wall, *paries membranaceus*, consists besides internally of the *tunica muscularis*, a layer of smooth muscle fibres which are stretched out, especially transversely, between the ends of the cartilages. The mucous membrane, *tunica mucosa*, is pale, and on the posterior wall is thrown up into longitudinal folds. It is connected with the underlying tissue by the *tela submucosa*, which consists of connective tissue, in which are numerous glands, *glandulae tracheales* (not illustrated), especially in the anterior and posterior wall; posteriorly, the largest are found in part between and behind the muscles.



671. Right lung, viewed from the medial surface.

The **lungs** *(pulmones)* (see also Figs. 670, 672, 678, 679, 682 and 683) are paired, approximately wedge-shaped organs, which fill up the lateral halves of the thorax, are connected with the trachea through its two subdivisions, the bronchi, and contain the terminal branches of these bronchi. They are covered on their outer surface by the pleura pulmonalis (see p. 587). Their color is reddish gray with blue and black spots.

Each lung presents above a blunt tip, *apex pulmonis*, and below a broad base, *basis pulmonis*, with the markedly concave *facies diaphragmatica*, which lies upon the diaphragm and is directed downward and medianward. The markedly convex *facies costalis* which looks forward, lateralward and backward is bounded by the ribs; it presents, corresponding to the intercostal spaces, flat bulgings, which are characterized by the presence of more marked accumulations of pigment. This surface with the facies diaphragmatica helps to form the sharp *margo inferior.* The medial surface, *facies mediastinalis,* is approximately vertical and is directed toward the pericardium and the medianstinal spaces; it forms with the facies costalis in front the sharp *margo anterior,* behind a blunt margin, while with the facies diaphragmatica it forms a part of the sharp margo inferior. The medial surface presents, nearer its posterior margin than its anterior, a club-shaped fossa, the *hilus pulmonis,* in which lie the bronchi and the vessels and nerves entering and leaving the lung and also several lymph nodules, *lymphoglandulae pulmonales.* The structures running to the hilus are grouped together as the *root of the lung, radix pulmonis* (see also Fig. 683). Behind the hilus on the left runs a deeper and broader furrow for the aorta thoracalis, on the right a flatter and narrower one for the v. azygos perpendicularly upward and then bends around forward. Connected with this toward the apex is a flat groove, the *sulcus subclavius,* for the a. subclavia. In front of and below the hilus lies a fossa, for the heart, *impressio cardiaca,* deeper on the left side and going over on the right side above into a groove for the v. cava superior.

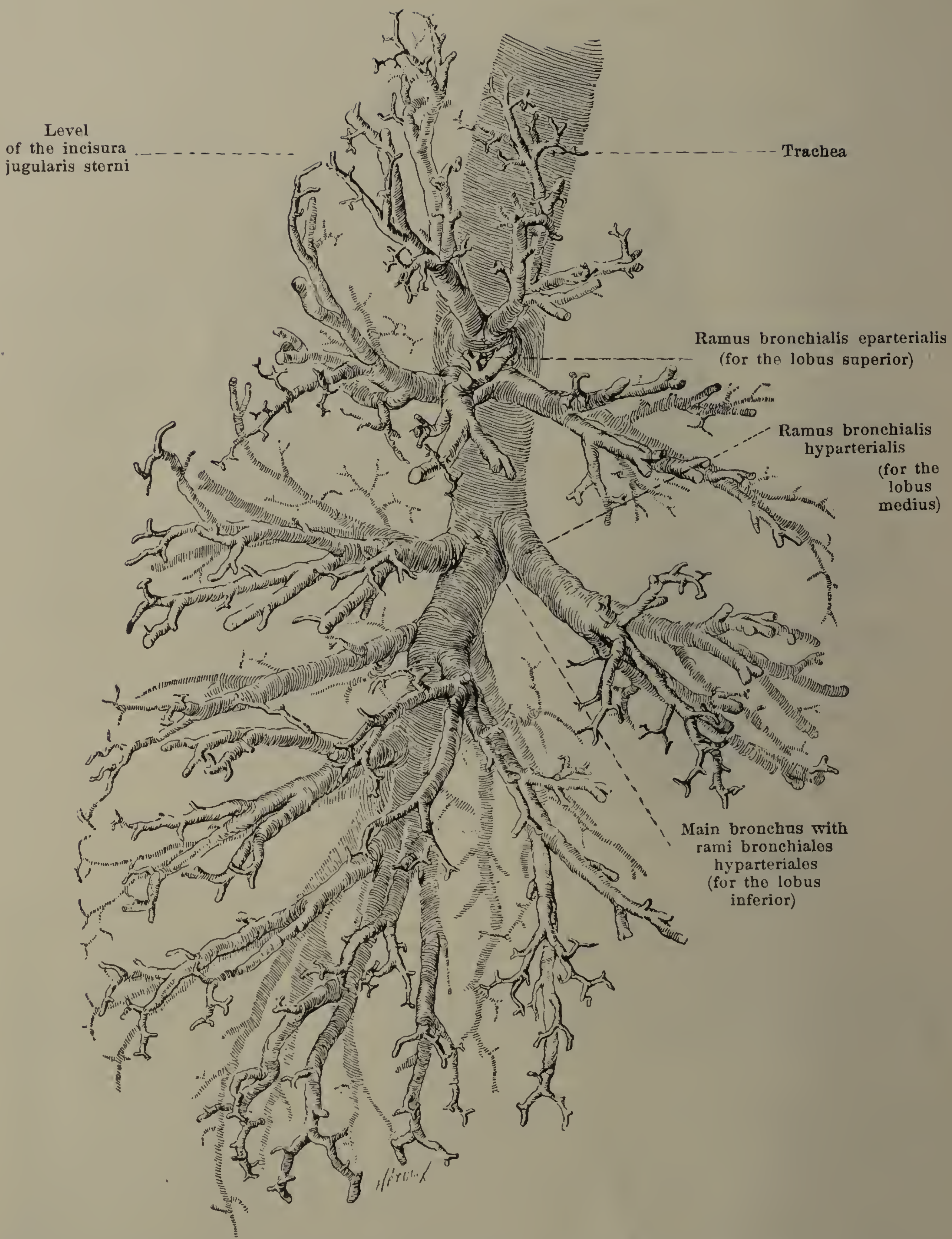


672. Left lung, viewed from the medial surface.

The **lungs** (continued). In each lung a fissure, the *incisura interlobaris*, which cuts through the whole substance almost as far as the hilus (see also Fig. 683) extends from behind and above forward and downward and separates a smaller, upper lobe, *lobus superior*, from a larger, lower lobe, *lobus inferior.* The fissure whose course often varies begins commonly somewhat below the apex at the level between the processus spinosi of the 2nd and 3rd thoracic vertebra, runs downward and forward (on the left somewhat more steeply than on the right) and reaches the margo inferior in about the region of the mammillary line. In the right lung in the region of the axillary line at the level of the 4th intercostal space there goes off from this incisure a second deep one which runs in an approximately horizontal direction and reaches the margo anterior at the level of the 4th rib; it together with the main incisure bounds the *lobus medius.* The margo interior of the left lung is deeply notched below, *incisura cardiaca;* the narrower portion projecting forward beneath it from the upper lobe is called the *lingula pulmonis.*

The right lung is somewhat shorter and broader and on the whole somewhat larger than the left. The volumes of the right and left lungs are in man in the ratio of 10: 9, in woman 8: 7.

Position of the lungs. The apex of the lung projects upward as far as in front of the neck of the first rib (see Figs. 679—681); it is somewhat higher and somewhat farther forward on the right than on the left and in the ordinary, upright position reaches from one to three cm above the extremitas sternalis claviculae. The margo inferior extends in front, on moderate expiration, first along the lower margin of the 6th rib, cuts the upper margin of the 7th rib in the mammillary line, crosses the 8th rib in the axillary line, the 9th and 10th rib in the scapular line, and reaches the spine at the level of the processus spinosus of the 11th thoracic vertebra; it thus runs lateralward and backward almost horizontally. The margo anterior begins above on both sides symmetrically behind the articulatio sternoclavicularis, extends thence on the right in a slightly convex curve toward the insertion of the 6th costal cartilage and goes in the middle of its extent a little beyond the median plane. On the left it runs in a corresponding direction as far as the level of the 4th costal cartilage and then curves at the incisura cardiaca first lateralward, then downward and somewhat medianward.

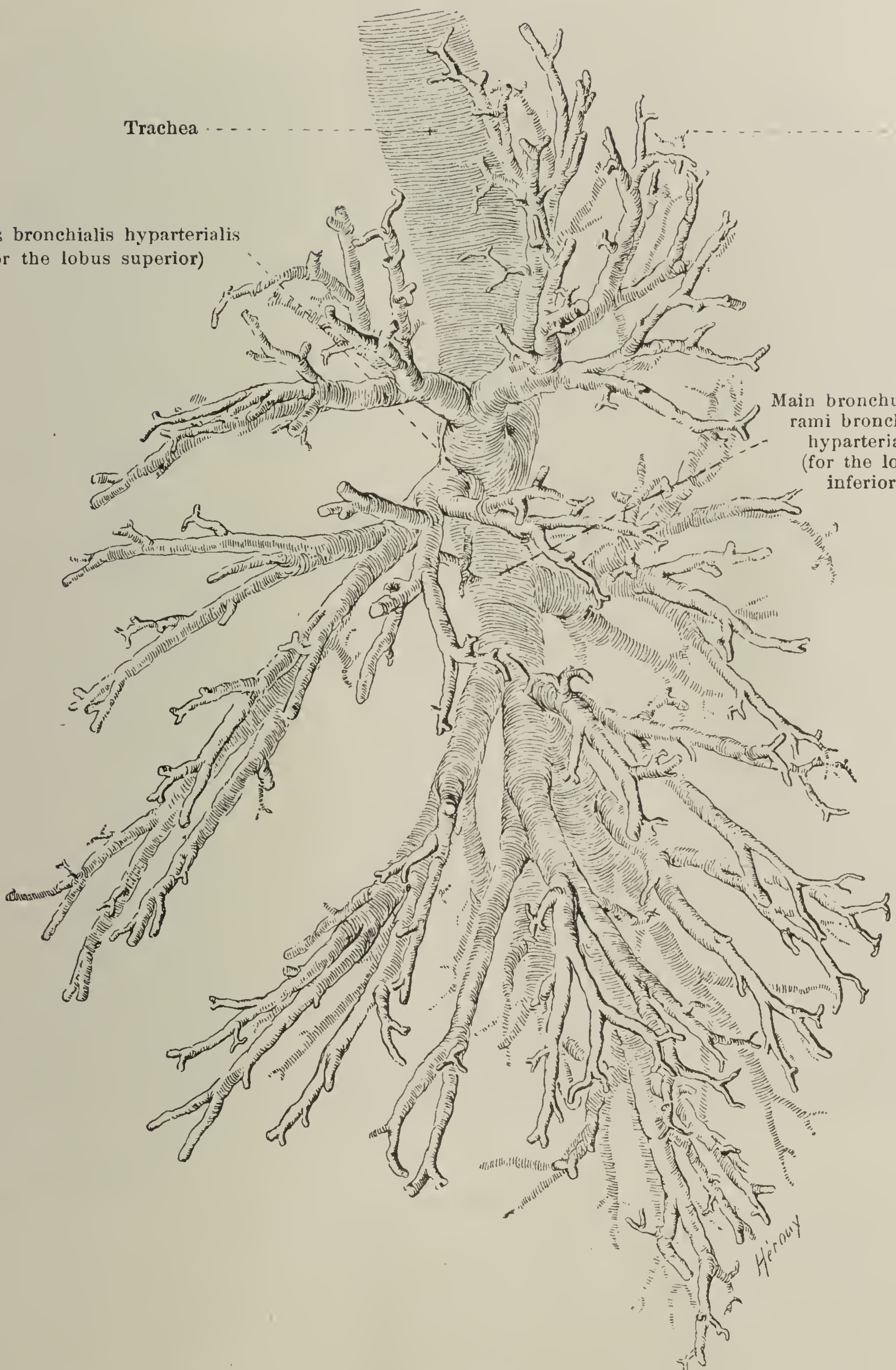

Level of the incisura jugularis sterni
Trachea
Ramus bronchialis eparterialis (for the lobus superior)
Ramus bronchialis hyparterialis (for the lobus medius)
Main bronchus with rami bronchiales hyparteriales (for the lobus inferior)
Hirsch

673. Cast of the air tubes and their branches,

viewed from the right, semi-schematic.

(After a preparation of F. V. Birch-Hirschfeld, with the aid of a drawing by Dr. M. Lange. Figs. 673—675 represent the same preparation.)

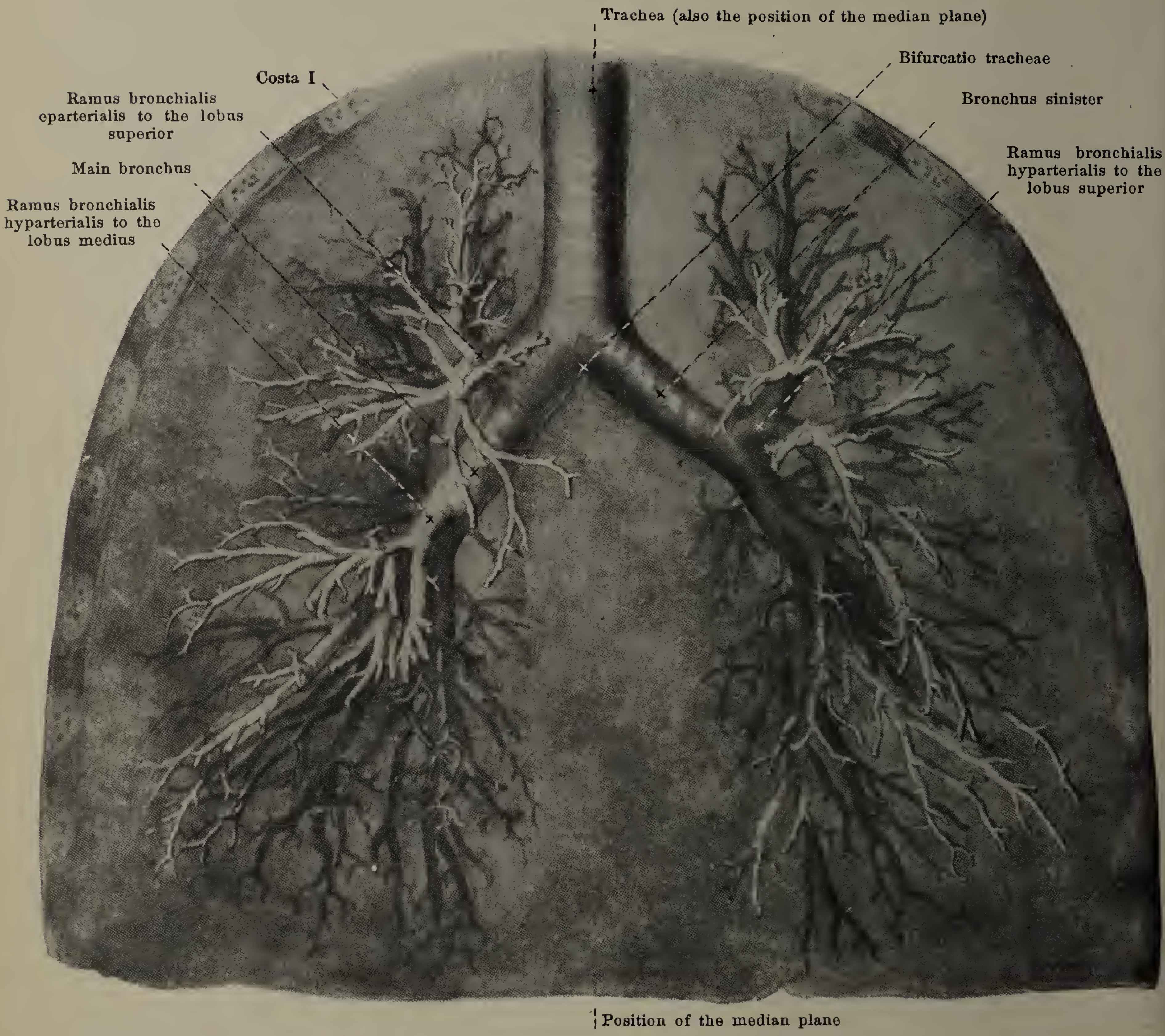
The two **bronchi,** *bronchus dexter* and *bronchus sinister* (see also Figs. 607, 674 and 675) extend out from the bifurcatio tracheae at an angle, usually less than 90°, and pass downward and lateralward to the hilus pulmonis. The non-branched part is steeper, shorter and a little wider on the right side than on the left. They are constructed exactly as is the trachea and have on the right side 6—8, on the left side 9—12 hyaline rings of cartilage which are open behind; they possess numerous glands, *glandulae bronchiales,* and single lymph follicles, *noduli lymphatici bronchiales.*


Trachea
Level of the incisura jugularis sterni
Ramus bronchialis hyparterialis (for the lobus superior)
Main bronchus with rami bronchiales hyparteriales (for the lobus inferior)
Héroux

674. Cast of the air tubes and their branches,
viewed from the left, semi-schematic.

(After a preparation of F. V. Birch-Hirschfeld, with the aid of a drawing by Dr. M. Lange. Figs. 673—675 represent the same preparation.)

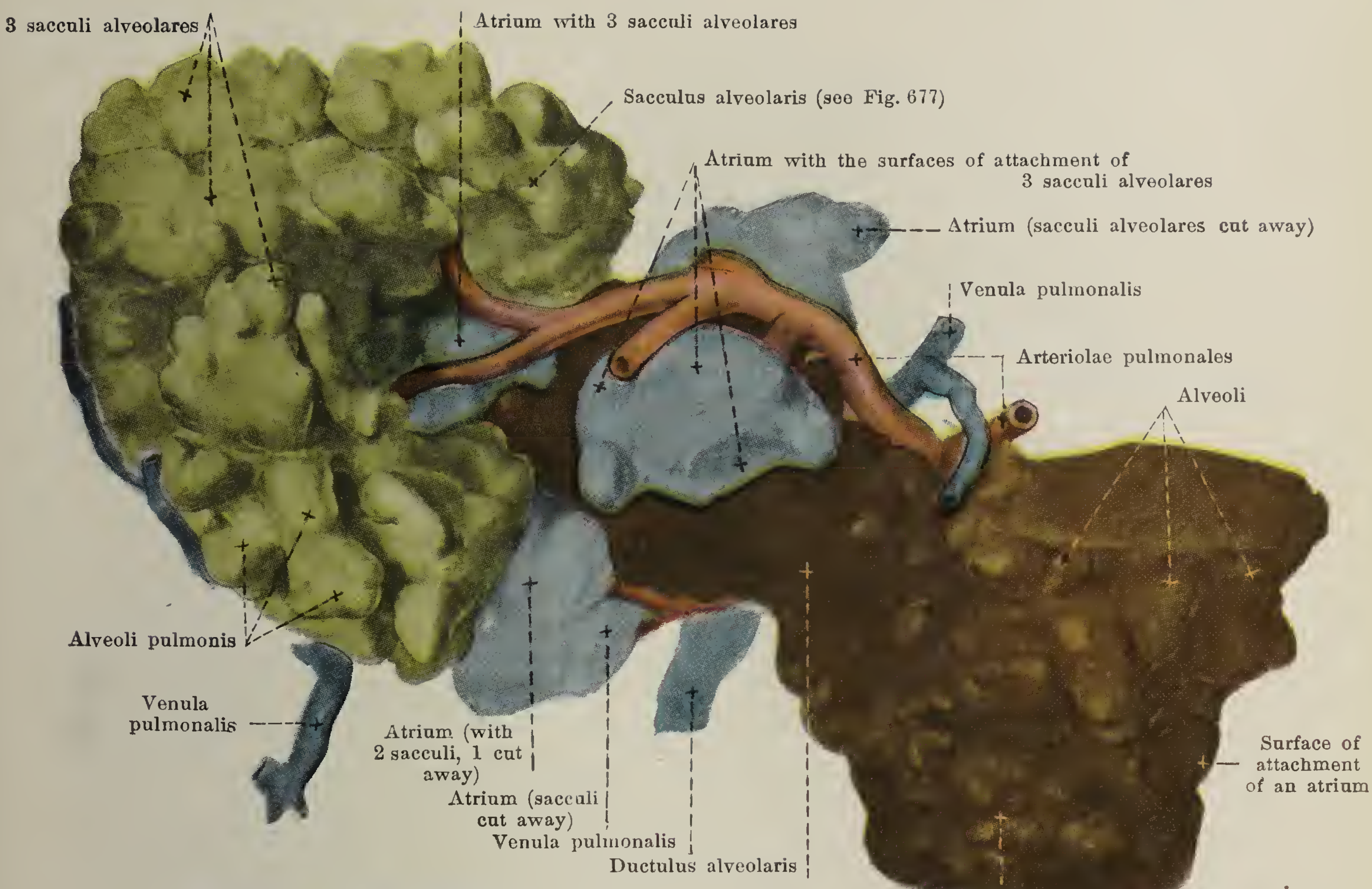
Position of the bronchus (see Figs. 607, 671, 672, 680 and 681). The branch of the a. pulmonalis runs on each side in front of the bronchus to the hilus, there lies on the anterior and upper surface of the bronchus and then curves around it lateralward to run into the lung along its posterior surface. The vv. pulmonales leave the hilus at the anterior and inferior surfaces of the bronchus. The a. bronchialis is situated in the hilus on the posterior surface of the bronchus. Above and behind the bronchus on the right side runs the v. azygos, on the left side the aorta thoracalis, behind it on both sides the n. vagus.


Trachea (also the position of the median plane)
Bifurcatio tracheae
Costa I
Ramus bronchialis eparterialis to the lobus superior
Bronchus sinister
Main bronchus
Ramus bronchialis hyparterialis to the lobus superior
Ramus bronchialis hyparterialis to the lobus medius
Position of the median plane

675. Cast of the air tubes and their branches, viewed from in front. (After a preparation of F. V. Birch-Hirschfeld, with the aid of a drawing by Dr. M. Lange. Figs. 673—675 represent the same preparation.)

Branching of the bronchi (see also Figs. 607, 673 and 674). The main bronchus *(stembronchus)* runs on each side as the continuation of and in the same direction as the corresponding subdivision of the trachea during its whole length as far as the posterior part of the basis pulmonis; the left one is curved slightly like the letter S. From it go off monopodic *lateral bronchi, rami bronchiales,* four ventral and four dorsal arising alternately. The first lateral bronchus supplying the lobus superior goes off on the right side above the place, where the bronchus and the branch of the a. pulmonalis cross one another, as a (single) *ramus bronchialis eparterialis;* on the left it arises below the place of crossing and belongs accordingly like all the other branches to the *rami bronchiales hyparteriales.* The middle lobe on the right side is supplied by the first ventral lateral bronchus. These lateral bronchi give off numerous branches which go on subdividing so that they become finer and finer and form the *bronchioli.*

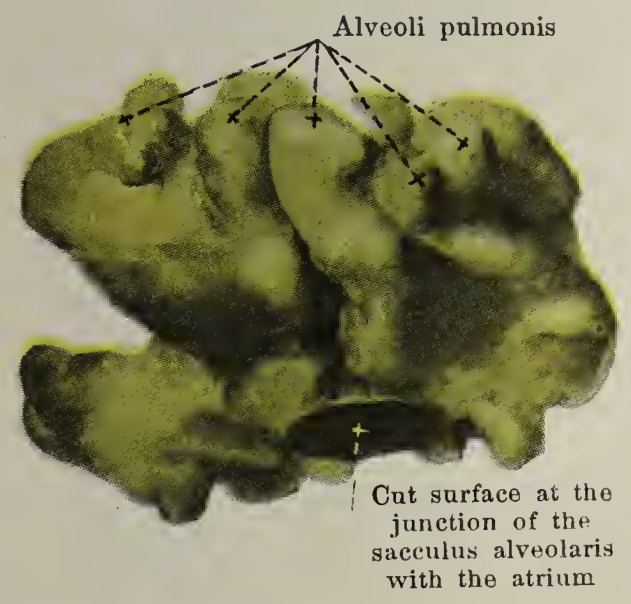
The main bronchi and their branches present only irregular cartilaginous plates which are distributed about the whole circumference of the tubes. They are larger at the beginning, where they are also closer together; they disappear in the tubes of 1 mm diameter; the larger ones have a hyaline ground-substance, the small tubes one with elastic fibres. Internally from them lies a circular layer of smooth muscle fibres and a mucous membrane. Glands are present on the outer surface of the muscles wherever the cartilages occur; *noduli lymphatici bronchiales* are present down to the finest branches.


3 sacculi alveolares
Atrium with 3 sacculi alveolares
Sacculus alveolaris (see Fig. 677)
Atrium with the surfaces of attachment of 3 sacculi alveolares
Atrium (sacculi alveolares cut away)
Venula pulmonalis
Arteriolae pulmonales
Alveoli
Alveoli pulmonis
Venula pulmonalis
Atrium (with 2 sacculi, 1 cut away)
Atrium (sacculi cut away)
Venula pulmonalis
Ductulus alveolaris
Surface of attachment of an atrium
Bronchiolus respiratorius

676. Alveolar duct, with branches and blood vessels, from the dog.

Magnification: 60 : 1

(After a wax-plate model by W. S. Miller.)

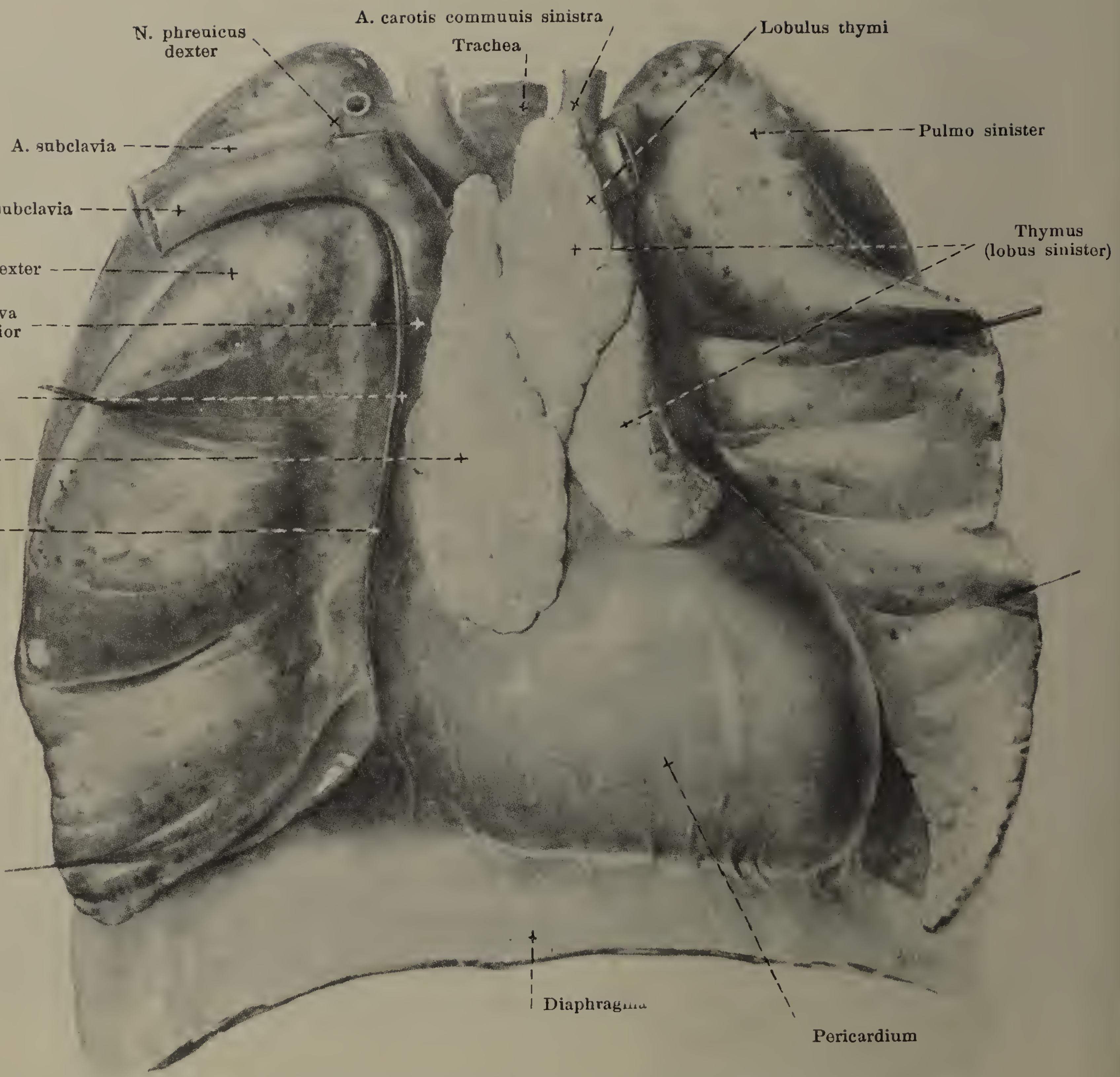

Alveoli pulmonis
Cut surface at the junction of the sacculus alveolaris with the atrium

677. Air saccule, by itself.

Magnification: 60:1 (see Fig. 676).

Mode of termination of the air spaces. Each bronchiolus divides farther into branches, *bronchioli respiratorii*, the walls of which are no longer smooth but present numerous small bulgings, *alveoli pulmonis.* Out of these bronchioli respiratorii, as terminal branches, pass the *alveolar ducts, ductuli alveolares,* which bear alveoli on all sides and lead through openings in their terminal piece into several approximately spherical spaces, *atria.* Each atrium is connected in turn with a number of larger and more irregular cavities, *air sacs, sacculi alveolares (infundibula),* the whole surface of which is closely set with small cavities, *alveoli pulmonis.* Each alveolar duct together with its branches forms a *lobule of the lung, lobulus pulmonis.* The bronchioli respiratorii and the ductuli alveolares still possess a circular layer of smooth muscle fibres but this is absent from the atria and sacculi alveolares.

The branches of the a. pulmonis accompany the air-conducting tubes as far as the atria and break up into capillaries on the sacculi alveolares. The smallest veins collect at the periphery of the lobule, receive tributaries from the points of division of the bronchioli and run at first between the lobules, separated as far as possible from the bronchioli and the arteries; only when the larger branches have been reached in the neighborhood of the hilus do they approach the anterior surface of the bronchi.



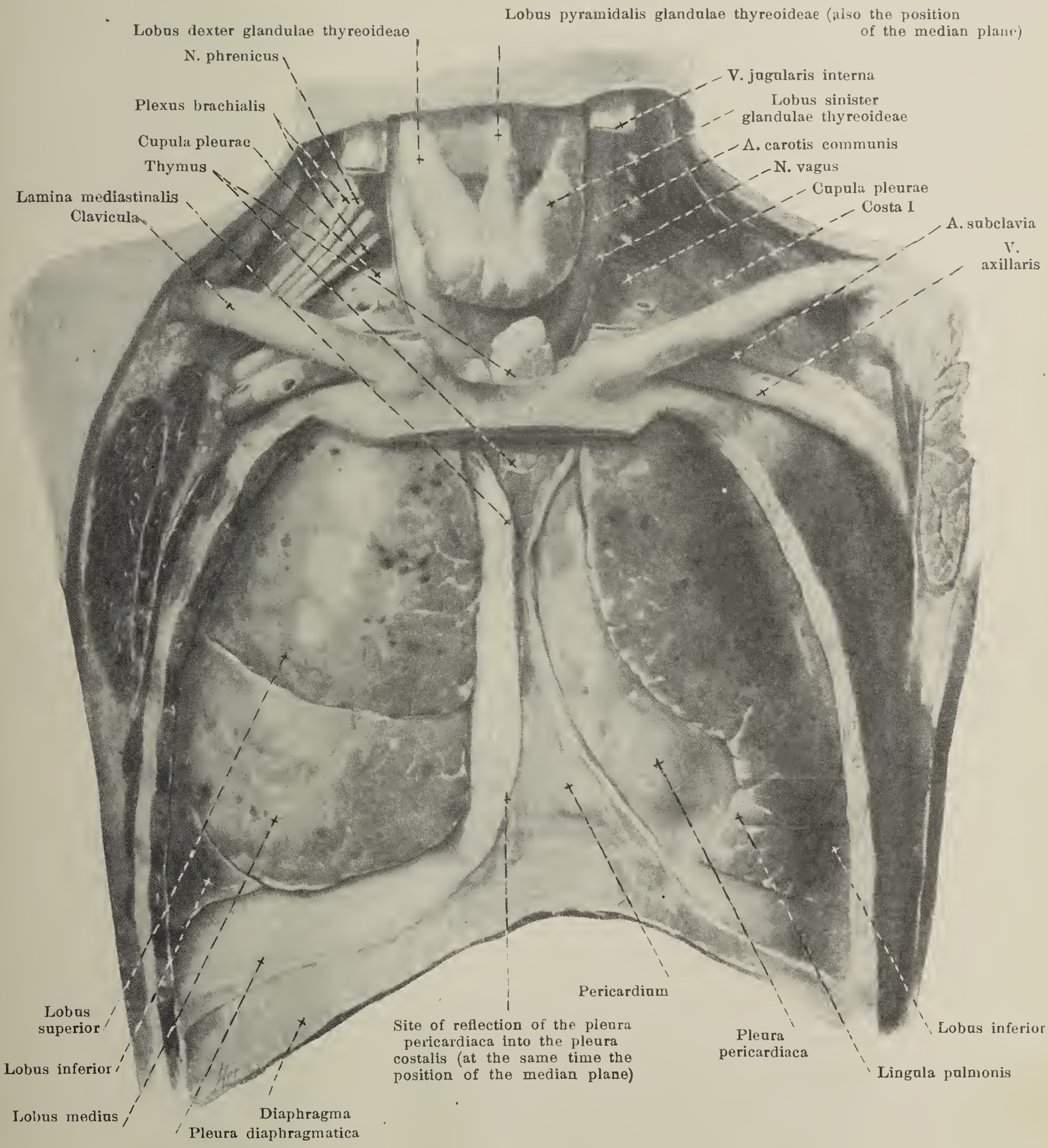
678. Thymus and pericardium

of a 12 year old boy, viewed from in front.

(The lungs have been drawn aside and the thymus and pericardium dissected out after removal of the pleurae mediastinalis.)

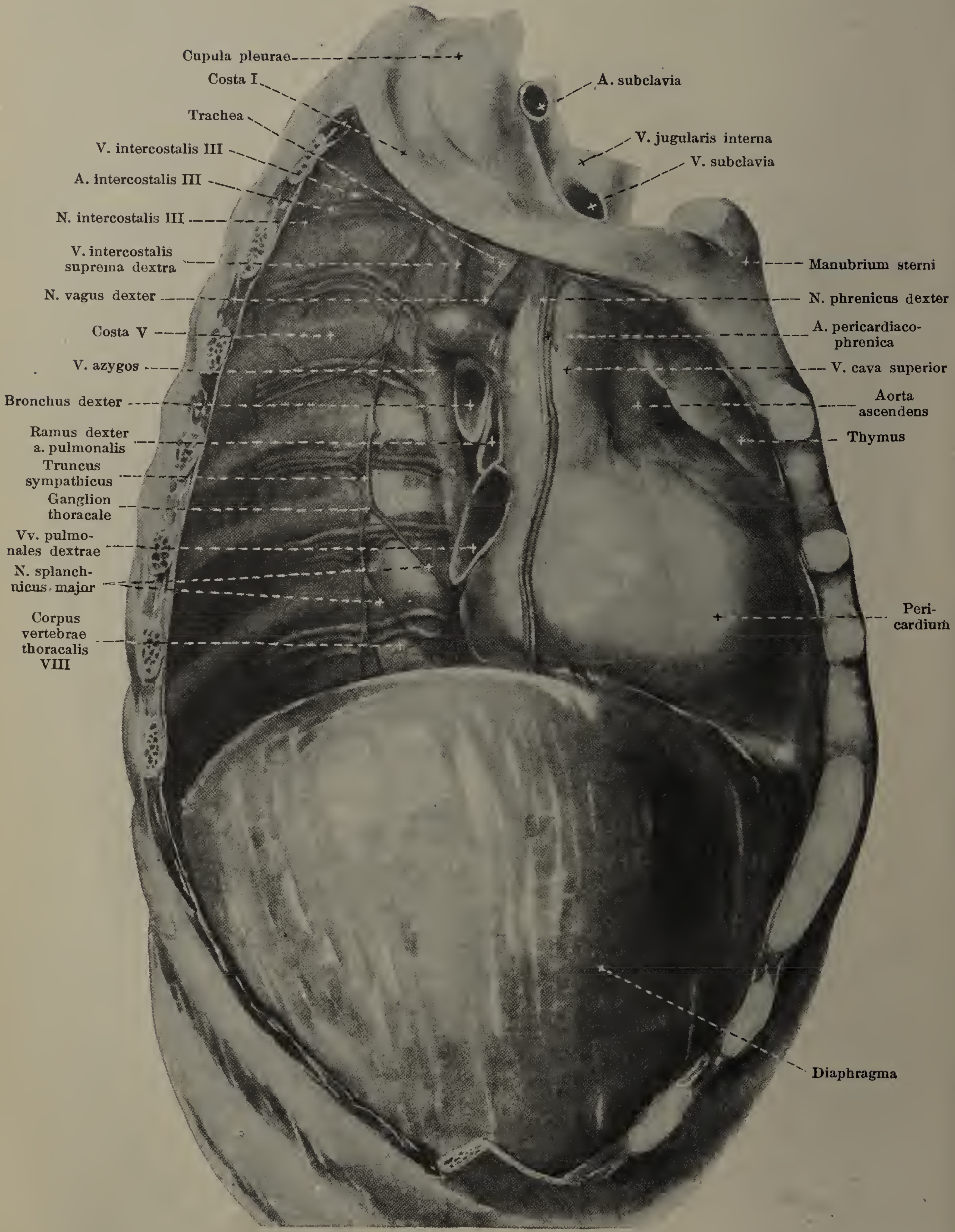
The **thymus**, or *thymus gland*, which develops as a paired organ from the ventral diverticula of the 3rd and 4th embryonal pharyngeal pouches, increases in size up to the beginning of puberty, and then in healthy individuals gradually decreases. From the 20th—25th year on the interstitial connective tissue, which in a person of mature age has the character of adipose tissue, exceeds greatly the parenchyma of the gland. The organ from birth shows no sexual differences; but later in life it seems to be lighter in woman than in man. It is of a grayish-red color, has an irregular flat-oblong shape and consists of two usually asymmetrical ***lobes***, ***lobus dexter*** and ***lobus sinister***, united only by loose connective tissue. Each of these lobes is composed of a large number of small ***lobules***, ***lobuli thymi***, which are separable from one another, but all are connected by a ***medullary cord***, ***tractus centralis*** (not illustrated), which follows a tortuous course inside the thymus and penetrates also into the lobules.

It lies (see also Figs. 679—681) just behind the sternum in the spatium mediastinale anterius, is bounded behind by the upper part of the pericardium, the v. cava superior, vv. anonymae, the arcus aortae and its branches, lateralward and partly in front by the pleura mediastinalis. Above it may reach behind the mm. sternothyreoidei as far as the glandula thyreoidea. Its anterior wall is loosely, the others more firmly connected with the surrounding tissues.

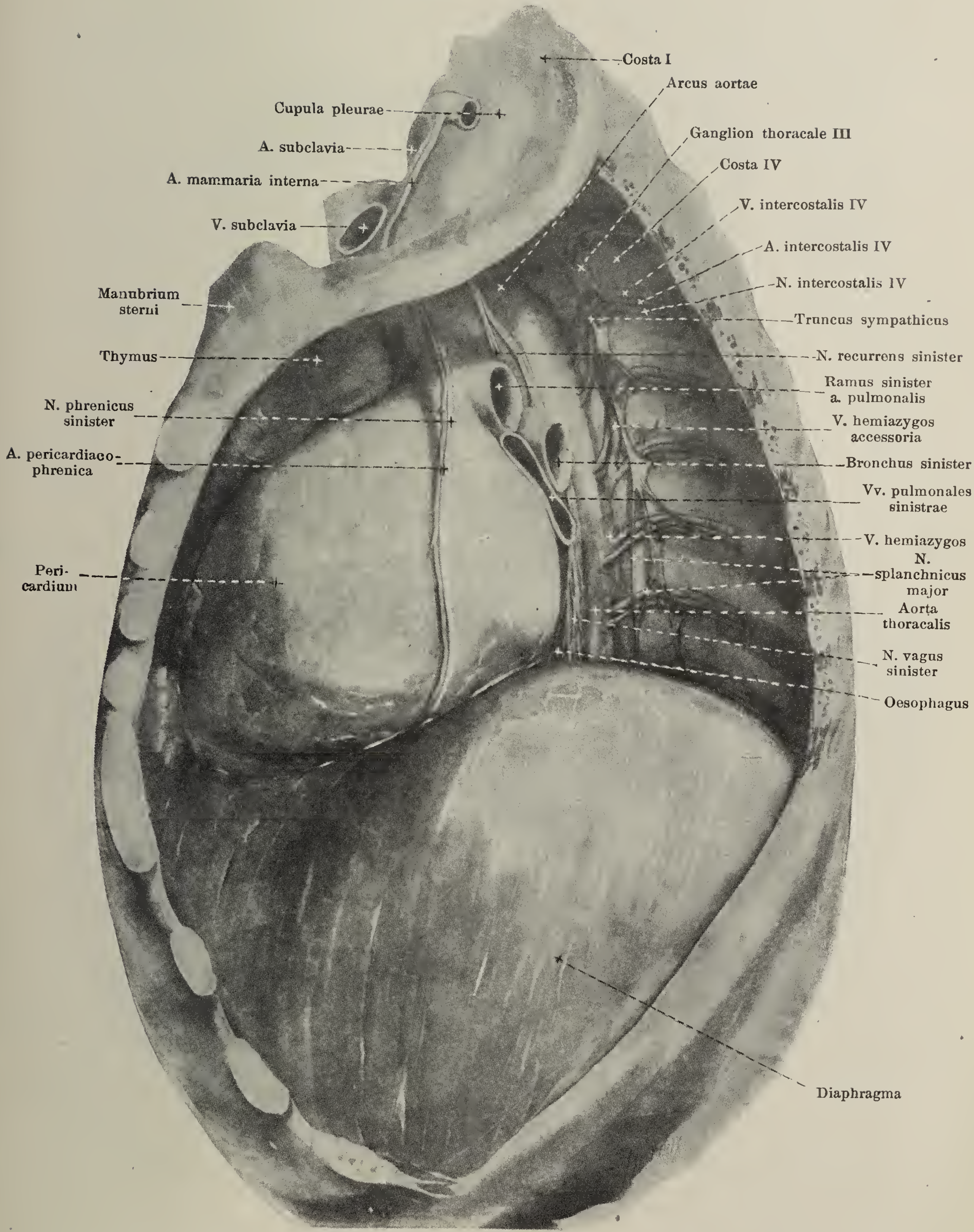


679. Thoracic viscera of a 12 year old boy, viewed from in front.
(The sternum and ribs have been removed. In the neck the cupulae of the pleurae have been exposed. The lungs are somewhat retracted.)

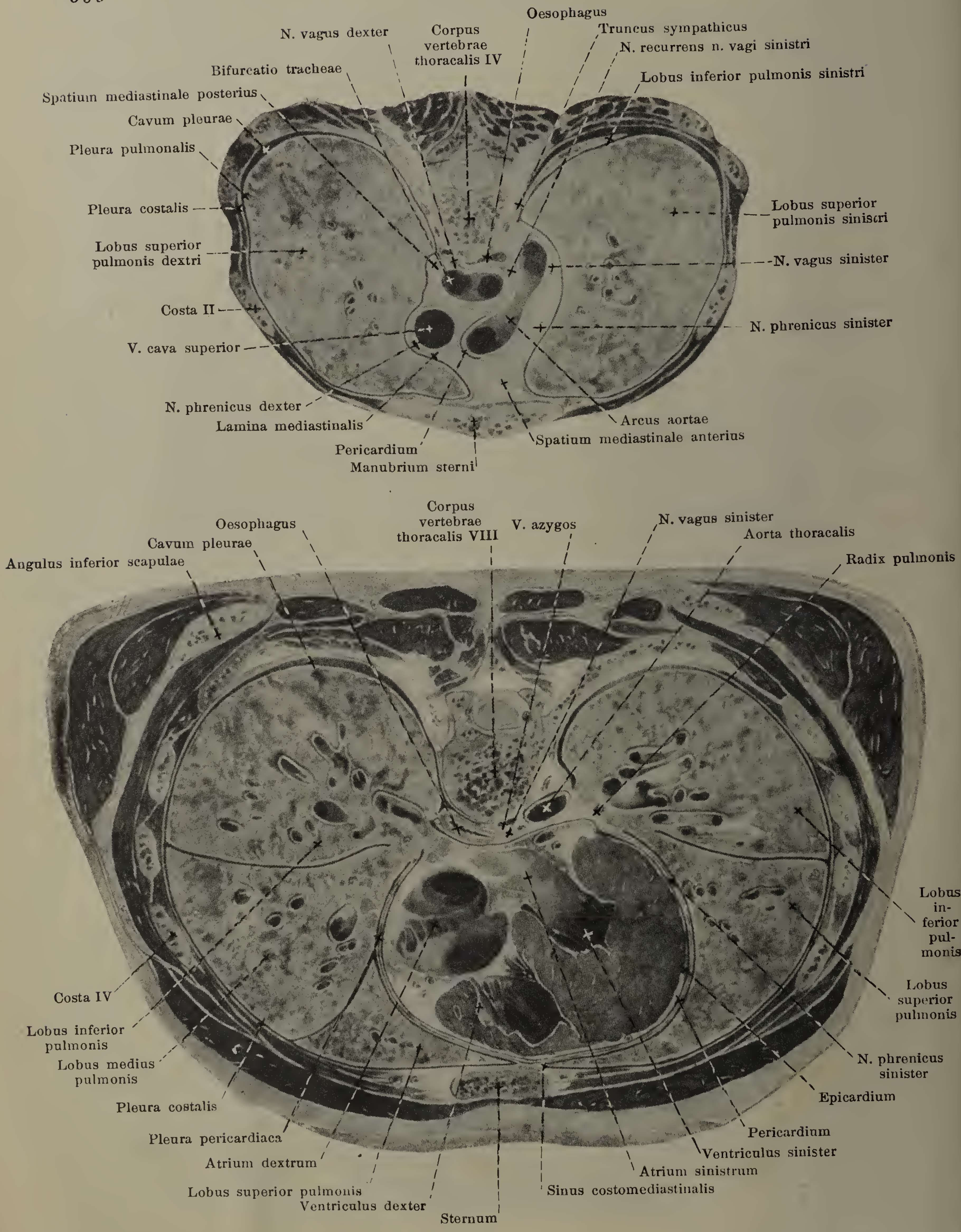
The **pleurae** (see also Figs. 682 and 683) are two smooth, glistening, serous membranes which cover the walls and viscera of the thoracic cavity *(cavum thoracis)*. They form, one in the right and one in the left half of the thoracic cavity, sacs complete in themselves, separated from one another by the septum mediastinale; one portion of each sac, *pleura pulmonalis*, covers the lung, and the other portion, *pleura parietalis*, the walls of the space occupied by the lung; the two portions go over into one another at the hilus pulmonis and inclose a slit-like space, *cavum pleurae*, which contains a very small amount of clear, serous fluid.



680. Right thoracic cavity and septum mediastinale, viewed from the right, after removal of the lungs and pleura.



681. Left thoracic cavity and septum mediastinale, viewed from the left, after removal of the lungs and pleura.



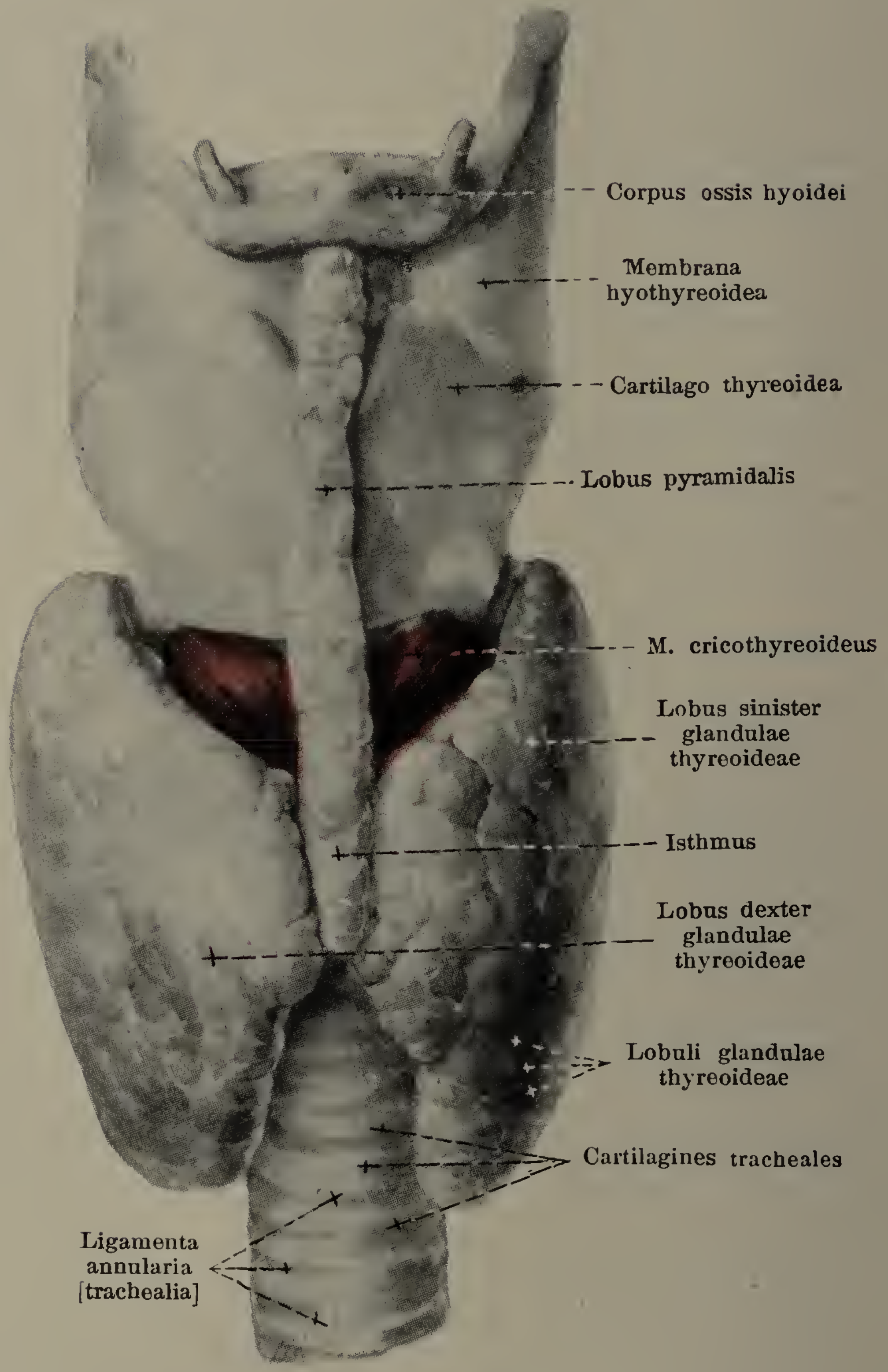
682 and 683. Cross-sections of the thorax,
viewed from above (after W. Braune).

Pleura (continued).

The ***pleura pulmonalis*** is intimately fused with the surface of the lung and follows it even into the depth of the incisurae interlobares (see Fig. 683). At the hilus it leaves the surface of the lung, is attached for a short distance to the root of the lung (see Fig. 683) and is then continued into the pleura mediastinalis. In so doing it forms below the hilus between the lung and the pleura mediastinalis a triangular duplicature, *ligamentum pulmonale*, the origin of which on the right lung runs in front of the groove for the v. azygos, on the left in front of the groove for the aorta thoracalis almost as far as the facies diaphragmatica (see Figs. 671 and 672); below it ends with a free margin or is attached to the pleura diaphragmatica.

The ***pleura parietalis*** is divisible into *pleura costalis, pleura diaphragmatica* and *pleura mediastinalis.* The *pleura costalis* (costal pleura) (see Figs. 682 and 683) covers the inner surface of the ribs on both sides, the lateral surface of the bodies of the thoracic vertebrae, partly also the posterior surface of the sternum, the mm. intercostales, subcostales and transversus thoracis, as well as the aa., vv. and nn. intercostales, a. and vv. mammariae internae, the truncus sympathicus and its branches. It is connected with these parts by the *fascia endothoracica* (not illustrated), a layer of connective tissue, which is strongest anteriorly behind the cartilages of the ribs and becomes thinner and looser posteriorly. Above the pleura forms a blind-sac-like prolongation, the *cupula pleurae* (see Figs. 679—681), which lies exactly at the apex of the lung and which accordingly projects as this does upward as far as the neck of the first rib (see p. 581). The cupula is related (from behind forward) to the lowermost bundle of origin of the plexus brachialis, to the ganglion cervicale inferius, the m. scalenus minimus, the a. subclavia with the first portions of the a. vertebralis and a. intercostalis suprema, the m. scalenus anterior, the a. mammaria interna and the v. subclavia, on the left also the ductus thoracicus; it is attached by the m. scalenus minimus and different bands of connective tissue upward to the cervical spine and fasciae. The *pleura diaphragmatica* (see Fig. 679) covers the upper surface of the diaphragm very firmly and exactly as far as the neighborhood of its origins from the ribs, where it is reflected into the pleura costalis; this line of reflection begins near the sternum at the lower margin of the 6th rib, cuts the 7th rib at the junction of the cartilage with the bone, the 8th rib behind it and reaches the spine at the lower border of the body of the 12th thoracic vertebra or of the processus transversus of the 1st lumbar vertebra below the attachment of the 12th rib. Between this line of reflection and the lower margin of the lung (see p. 581) the pleura diaphragmatica lies on the pleura costalis for some distance and with it bounds the *sinus phrenicocostalis.* During inspiration the lung passes into this *sinus pleurae* which then becomes smaller, but is not, as a rule, totally obliterated in its most dependent parts, since the lung generally does not pass as far as the line of reflection.

The right and the left cavum pleurae are separated by the ***septum mediastinale*** which is narrower above and broader below and contains chiefly the heart, the great vessels, the trachea, the oesophagus and the thymus gland (see Figs. 680—683). This septum is covered right and left by the ***pleura mediastinalis;*** that portion of this which is very firmly fused with the parietal layer of the pericardium is designated as *pleura pericardiaca*, the rest of it as *lamina mediastinalis.* The pleura mediastinalis is connected in front and behind with the pleura costalis, below with the pleura diaphragmatica. The anterior line of reflection (see Fig. 679) runs on the right as does the anterior margin of the right lung (see p. 581), on the left in a similar curve but so that it usually lies lateralward from the medial end of the 5th left intercostal space; as a result of this the pleurae of the two sides may come into contact with one another between the 2nd and 4th costal cartilages but are usually separated, however, especially in younger individuals by a layer of loose tissue. The starting point of the mediastinal pleura behind lies on the lateral surface of the bodies of the vertebrae. Toward the apex the pleura mediastinalis goes over into the medial wall of the pleural cupula; below this it extends almost directly (see Fig. 682) from before backward and in so doing directly covers on both sides the thymus, nn. phrenicus and vagus, on the right side (see Fig. 680) the vv. cava superior, anonyma dextra and azygos, as well as the trachea, on the left side (see Fig. 681) the aorta thoracalis and the a. subclavia sinistra. The pleura mediastinalis is curved out lateralward below (see Fig. 683), more markedly on the left than on the right side, but in the neighborhood of its posterior portion it is interrupted by the hilus pulmonis and the ligamentum pulmonale, upon which it becomes reflected; it thus directly covers as pleura pericardiaca in front the pericardium, the nn. phrenici and the accompanying vessels, behind the oesophagus with the nn. vagi (on the right in the middle, on the left below) as well as on the right the v. azygos and the vv. intercostales dextrae and on the left the aorta thoracalis. Anteriorly, where the pleura costalis goes over into the pleura mediastinalis, more distinctly visible below than above, is a slit-like space, *sinus costomediastinalis* (see Fig. 683), which on inspiration is, in general, completely filled up by the margo anterior of the lung; only the portion situated in front of the heart and corresponding to the incisura cardiaca (see Fig. 679) remains free from the lung even on deepest inspiration. In the sinus phrenicocostalis and in the groove between the pleura diaphragmatica and the pleura mediastinalis are frequently situated lobe-like adipose appendages of the mediastinum, *plicae adiposae* (not illustrated), which carry small villous projections, *villi pleurales.*


Corpus ossis hyoidei
Membrana hyothyreoidea
Cartilago thyreoidea
Lobus pyramidalis
M. cricothyreoideus
Lobus sinister glandulae thyreoideae
Isthmus
Lobus dexter glandulae thyreoideae
Lobuli glandulae thyreoideae
Cartilagines tracheales
Ligamenta annularia [trachealia]

684. Thyroid gland,

in its position to the larynx and to the trachea, viewed from in front.

Pleura (continued).

The ***septum mediastinale*** is divided into two portions of different size, which are separated only indistinctly from one another by the heart with the pericardium, the central part of the large vessels, the roots of the lungs and the trachea. The smaller, anterior portion, *spatium mediastinale anterius,* contains the aa. and vv. mammariae internae, nn. phrenici, thymus gland and lymph glands; the posterior, *spatium mediastinale posterius*, contains the aorta thoracalis, aa. and vv. intercostales dextrae, vv. azygos and hemiazygos, ductus thoracicus, nn. vagi and splanchnici, oesophagus and lymph glands (see also Figs. 682 and 683).

The **thyroid gland** *(glandula thyreoidea)* (see Figs. 358, 567, 679, 684 and 685) is an unpaired very variable, frequently asymmetrical gland, which in the early embryonal period opens to the outside by means of an duct, *ductus thyreoglossus* (see p. 507), but later forms a body completely shut off from the surface. It is of a bluish-red or reddish-yellow color, lies upon the lateral surface of the larynx as well as upon the lateral and anterior surfaces of the upper end of the trachea and surrounds the latter like a horse-shoe. It is covered in front (see Figs. 349 and 353) by the mm. sternothyreoidei, omohyoidei, sternohyoidei and sternocleidomastoidei. It presents for examination two *lateral lobes, lobus dexter* and *lobus sinister*, which are united with one another in front by means of a *middle piece, isthmus glandulae thyreoideae.* The oblong and thick *lateral lobe* lies on each side on the lateral surface of the trachea and oesophagus as well as on each side of the larynx and pharynx. On the thyroid cartilage it reaches only as far as the insertion of the m. sternothyreoideus; from there on it is pressed somewhat backward and becomes drawn out into a pointed process which may extend as far as the hyoid bone. Its medial surface is in contact below also with the n. recurrens (X); its posterior surface is in contact with the a. carotis communis (which usually makes a groove-like impression upon it), the a. thyreoidea inferior and the v. jugularis interna, above also with the fascia praevertebralis; the anterior surface, directed at the same time lateralward, is covered by the above-mentioned muscles. The *middle piece* is essentially shorter and covers the 2nd, 3rd and 4th, very often also the 1st cartilago trachealis; going out from it, usually from the left side, is often a process, variable in from, the *lobus pyramidalis,* which passes in front of the thyroid cartilage upward toward the middle of the hyoid bone, but does not always reach it. The isthmus varies much in its development and may be absent altogether. The gland consists of connective tissue, *stroma glandulae thyreoideae,* in which lie small gland vesicles, which are arranged in larger groups, *lobuli glandulae thyreoideae.*

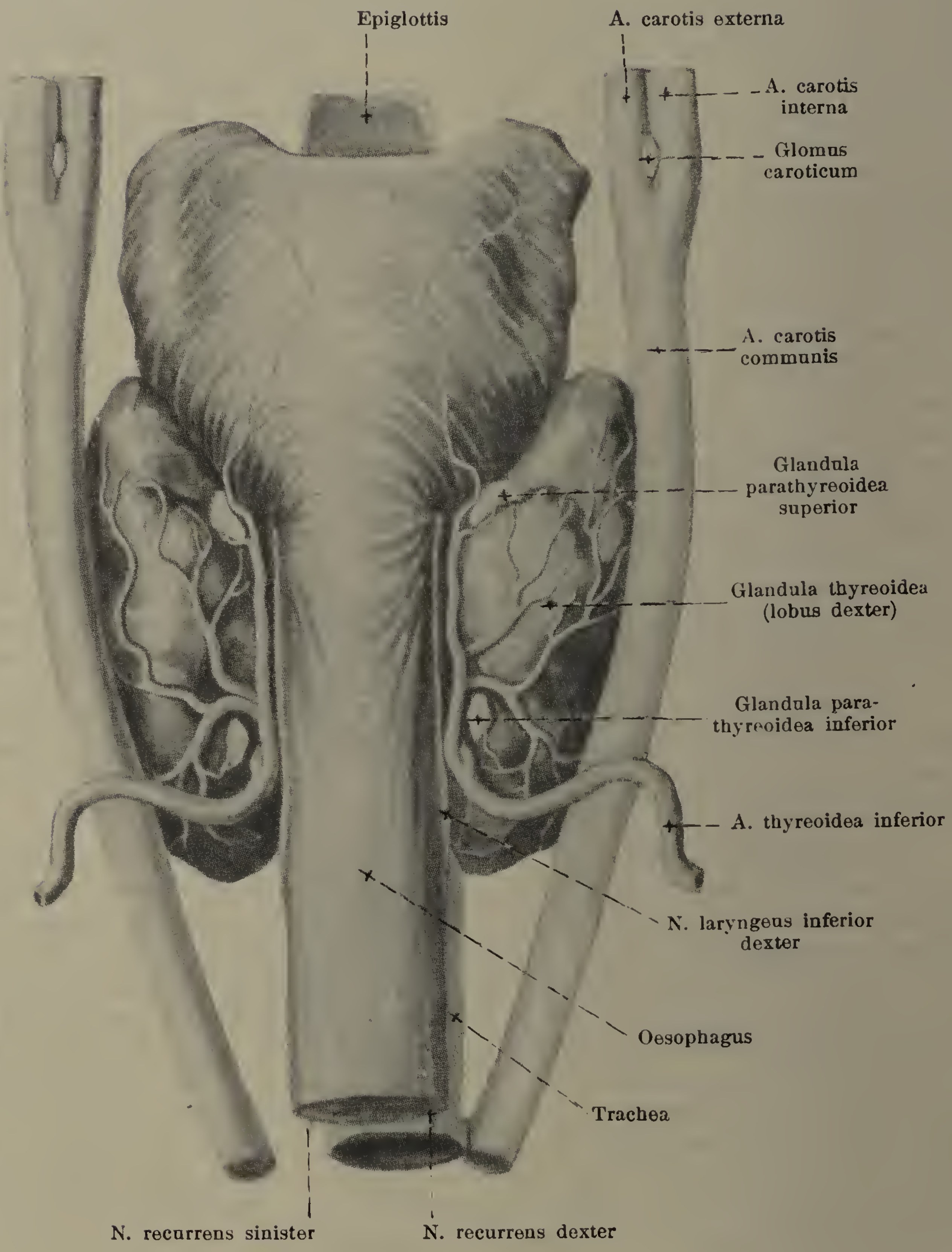
The *glandulae thyreoideae accessoriae* (not illustrated) are small masses of thyroid tissue which may occur close above the hyoid bone *(glandula thyreoidea accessoria suprahyoidea),* in the course of the lobus pyramidalis or dorsal of the thyroid gland, in the lateral region of the neck, or upon the trachea as far down as the arcus aortae.

The ***glandulae parathyreoideae*** *(epithelial bodies)* (see Fig. 685) are usually two on each side, a *superior* and *inferior* one. They are solid epithelial structures, which are situated on the dorsal surface of the thyroid gland next to small accessory thymus and thyroid lobules and lymph glands. They are developed from the dorsal diverticula of the 3rd and 4th embryonal pharyngeal pouches, and in the course of development become so shifted that the one corresponding to the 3rd pouch becomes the lower (caudal), and the one from the 4th pouch the upper (cranial) one. Their number (both sides together) is in adults often diminished to 3 or 2. They are of a yellowish-red or yellowish-brown color and have a uniform smooth and shining surface. Their form and size is very variable. They are flattened, mostly oval, and sometimes pointed at the ends. Their length is usually 6—8 mm, their width 3—4 mm and their thickness 1,5—2 mm, the length being very variable, the thickness rather constant. The epithelial bodies are proportionately larger in size in the child than in the adult. The right and left parathyroids are seldom placed symmetrically.

The upper parathyroid is situated in the median portion of the posterior surface of the lateral lobe of the thyroid, frequently in a notch of the latter, next to the wall of the pharynx or oesophagus, about the level of the lower border of the cartilago cricoidea, and is usually separated from the thyroid by loose connective tissue. The ascending branch of the a. thyreoidea inferior, which gives off the a. laryngea inferior, and the n. laryngeus inferior run somewhat ventrally and medially to it.

The lower parathyroid is less constant in its position and relations. It lies close to the lower pole of the lateral lobe of the thyroid gland near the 3rd and 4th cartilage ring of the trachea, ventrally to the ascending branch of the a. thyreoidea inferior and n. laryngeus inferior; sometimes it is found nearer to the upper superior parathyroid or more caudally from the thyroid on the trachea.

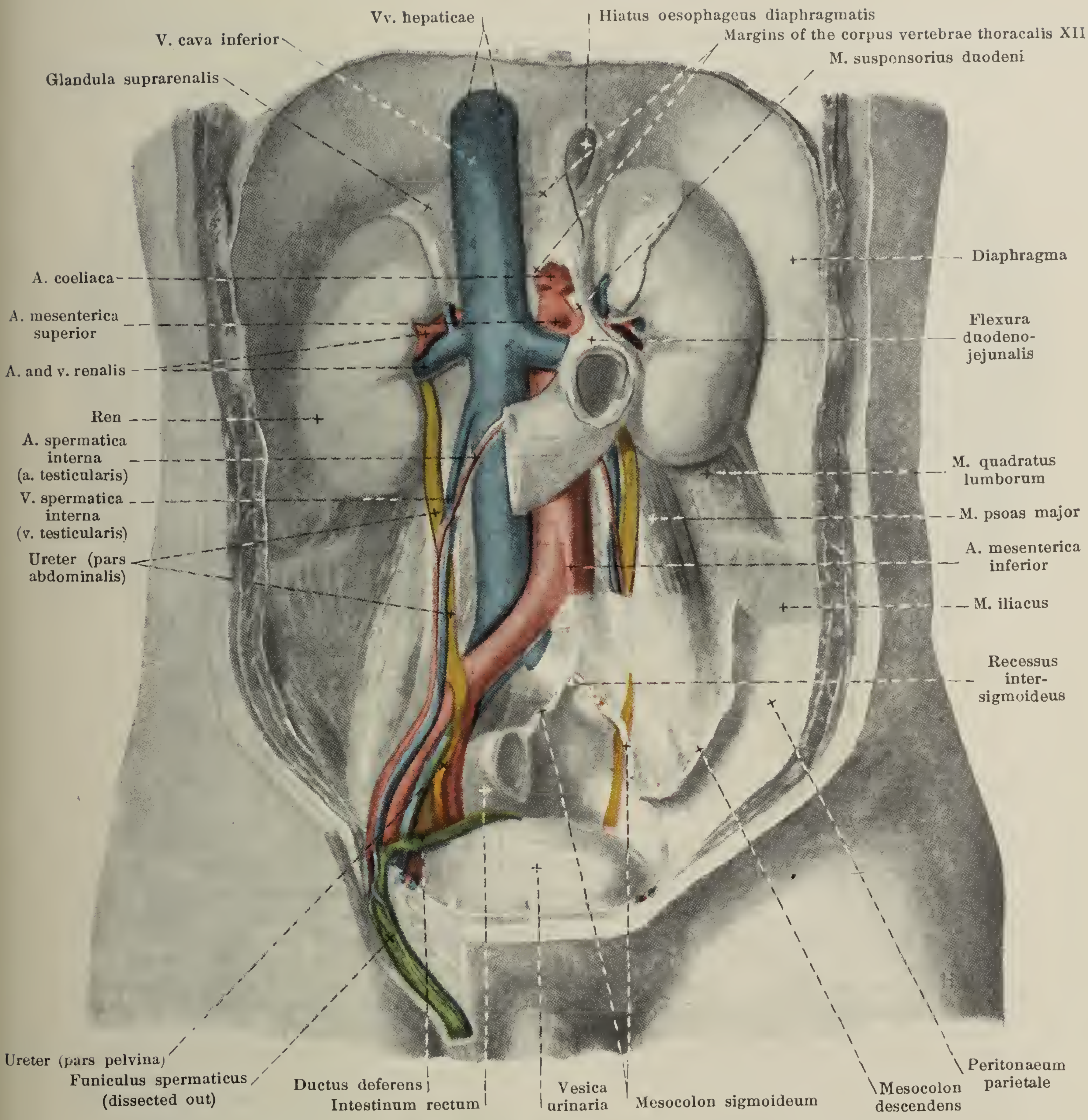
There have also been observed internal epithelial bodies enclosed at all sides from the thyroid tissue.



685. Thyroid gland and its relation to the surrounding organs, from behind.

(The carotid arteries are turned a little outward so that the carotid glands may be seen.)

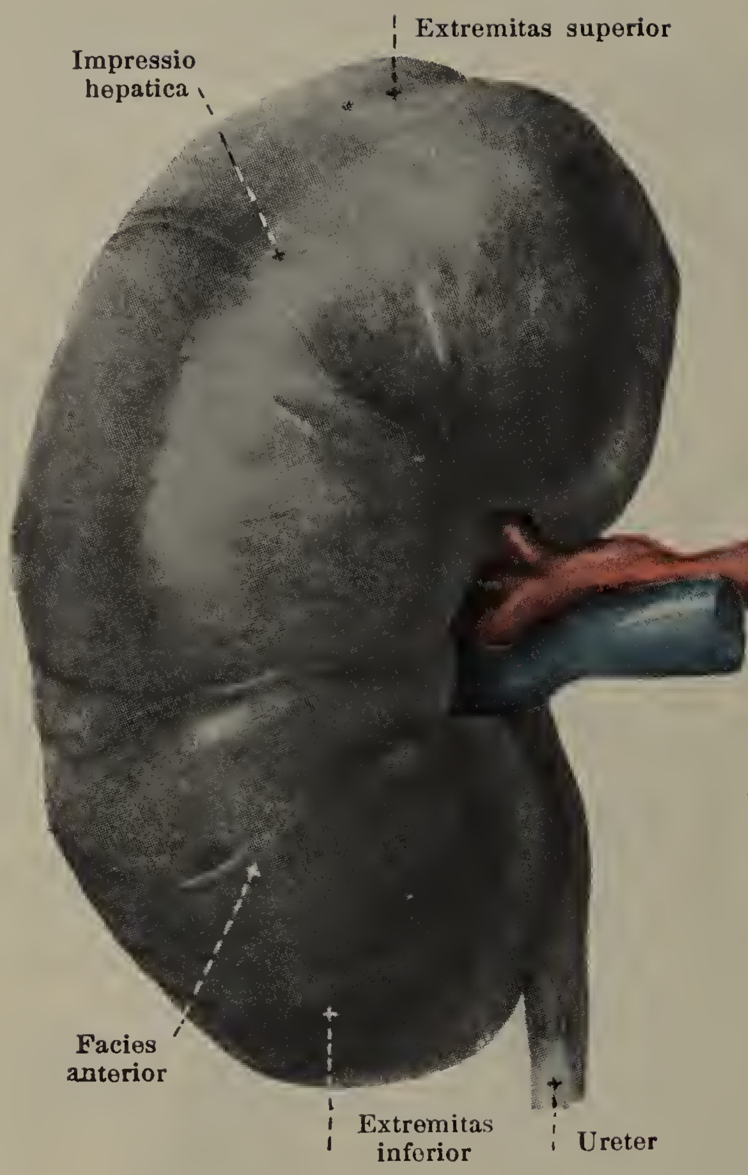
The ***glomus caroticum*** *(Paraganglion intercaroticum, carotid gland)* is an oblong, flattened body about 5 mm long, which is situated immediately above the division of the a. carotis communis directly on the medial surface of this artery and of its both branches. It sometimes consists of 2—5 nodules of hard consistency and of grayish-red or brownish-red color. It consists of chromaffin cells and abundant vascular and nervous elements.

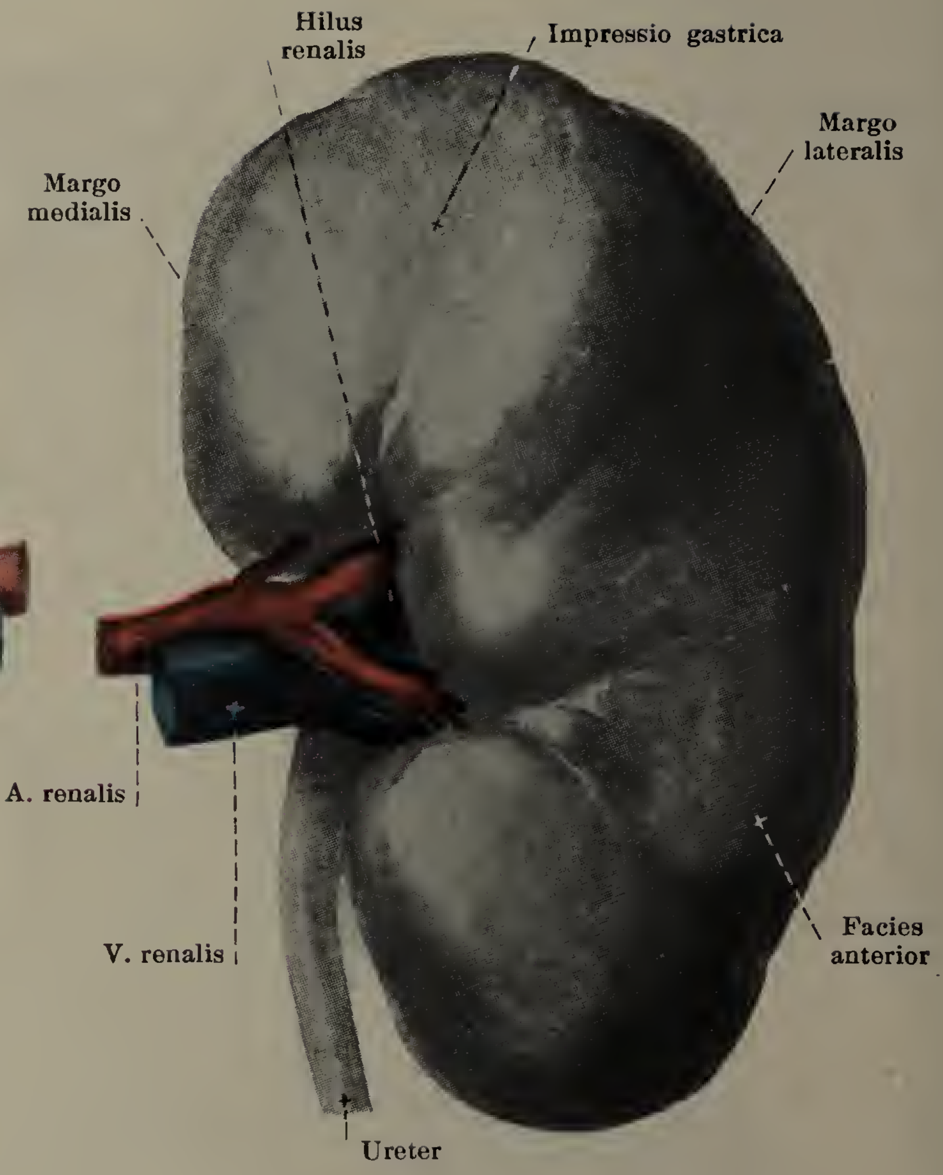


686. Urinary organs in a male, viewed from in front.

(Of the intestine only the termination of the duodenum has been left; the peritonaeum, with the exception of the inferior portion on the left side, has been removed. The margins of the bodies of the vertebrae are indicated by interrupted lines.)

The **kidneys** *(renes)* are two large glands, which are situated, one on each side, in the upper part of the posterior wall of the abdominal cavity near the spine. The posterior surface of the kidney, directed at the same time medianward, lies in front of that portion of the diaphragm which arises from the arcus lumbocostales, as well as in front of the mm. psoas major, quadratus lumborum and transversus abdominis and is separated from them by a layer of loose tissue, rich in fat, the *capsula adiposa.* In the male the left kidney reaches usually from the 11th thoracic vertebra as far as the upper border of the 3rd lumbar vertebra; the right lies usually deeper by the distance of from a half to a whole vertebral level. In the female both kidneys are lower down by about one half a vertebra but do not reach normally the level of the crista iliaca. The twelfth rib runs obliquely downward behind the posterior surface of the kidney. The upper part of the kidney accordingly still remains in the domain of the sinus phrenicocostalis of the pleura.





687. Right kidney, **688. Left kidney,**

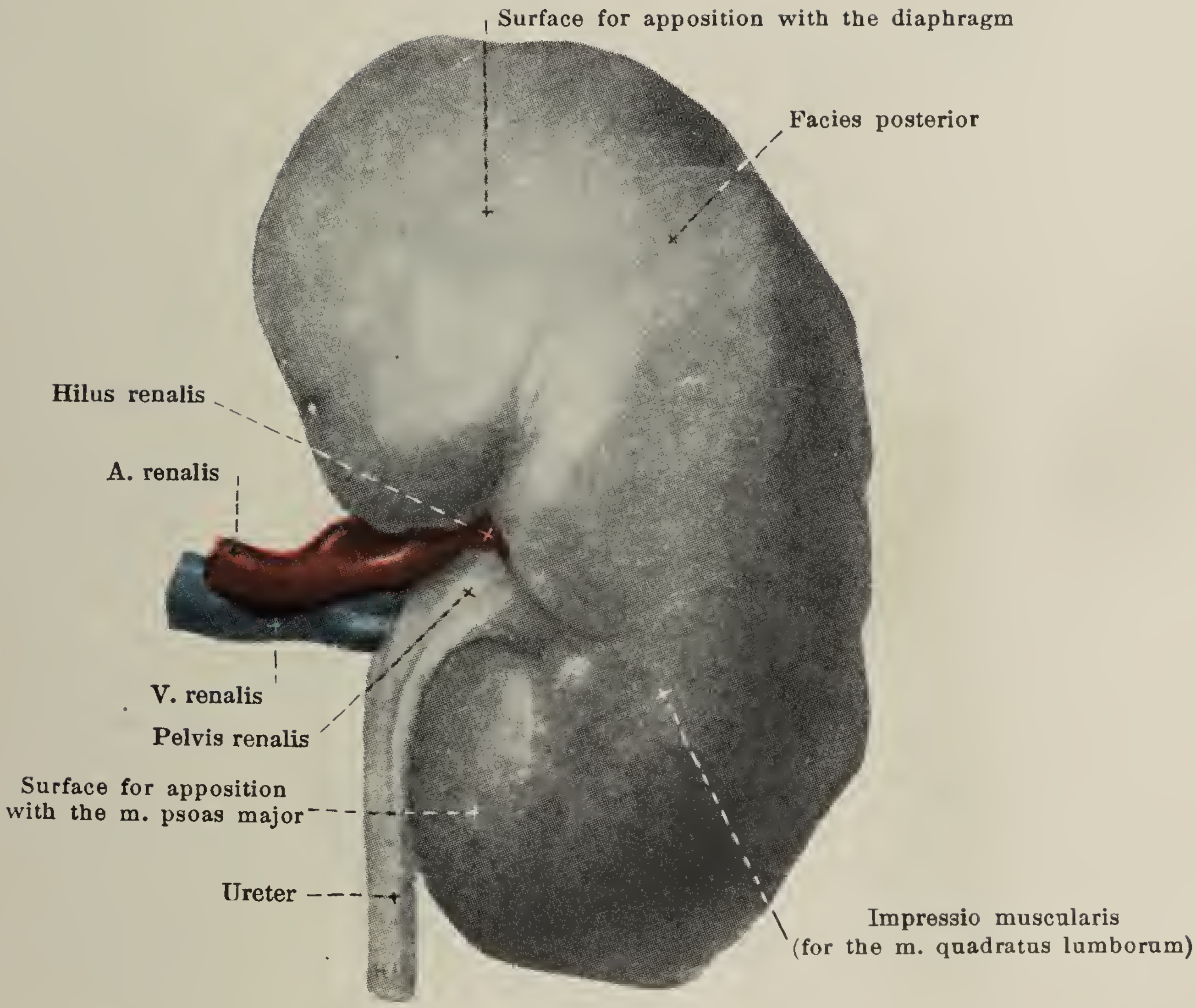
viewed from in front.

Position of the kidneys (continued) (see Fig. 686).

Their largest planes of section cut one another in front of the spine, and their upper poles lie nearer the median plane than their lower poles. The anterior, lateral surface is covered by a feebly developed capsula adiposa (see p. 595) and right and left shows differences in relations as regards the neighboring organs. The right kidney (see Fig. 645) is lateralward almost entirely covered by the liver, its upper pole is closely related medianward to the suprarenal gland, and in front of its medial margin the pars descendens duodeni passes downward; its lower pole is in contact for a variable extent (see p. 542) with the flexura coli dextra. It is covered by peritonaeum parietale to the extent of its surface of contact with the liver, only with the exception of the uppermost end. On the left kidney at the medial margin of its upper pole lies the suprarenal, on the upper part of its anterior surface the paries posterior of the stomach, below this the facies posterior of the pancreas and the vasa lienalia, and at the lowest part lie several loops of the jejunum; on the upper part of its lateral margin lies the facies renalis of the spleen; along the lower part of its lateral margin it is covered by the flexura coli sinistra and by the colon descendens. The peritonaeum covers on the left the portions related to the spleen and the stomach; that covering the latter looks into the bursa omentalis; the peritonaeum also covers the surface situated below the pancreas, with which the mesocolon transversum and descendens is fused.

Form of the kidneys (see also Fig. 689).

Each kidney has the shape of a flattened bean. It presents an upper, broader and thinner end or *pole*, *extremitas superior*, and a lower, narrower and thicker, *extremitas inferior*, as well as a markedly convex lateral border, *margo lateralis*, and a feebly convex medial, *margo medialis*. The latter presents in the middle an oblong fossa which cuts in deep, and is bounded by convex margins, the *hilus renalis*, in which the a. renalis enters and from which the v. renalis and the ureter emerge; it goes over into a deep slit, *sinus renalis*, which runs into the kidney in a longitudinal direction and contains the pelvis of the kidney (see Fig. 691).


Surface for apposition with the diaphragm
Facies posterior
Hilus renalis
A. renalis
V. renalis
Pelvis renalis
Surface for apposition with the m. psoas major
Ureter
Impressio muscularis (for the m. quadratus lumborum)

689. Right kidney, viewed from behind.

Form of the kidneys (continued).

The anterior surface *(facies anterior)* (see Figs. 687 and 688) is convex. On the right side its upper part is usually somewhat flattened corresponding to its apposition with the liver, *impressio hepatica;* on the left the stomach causes a trough-like depression, often very marked in its upper part, *impressio gastrica.* The posterior surface, *facies posterior*, has a somewhat flatter curve. It presents in its lower part a variable marked impression, *impressio muscularis*, for the m. quadratus lumborum and medianward from it frequently a flattened surface for the m. psoas major; in the upper half the surface for apposition with the diaphragm is often distinctly recognizable.

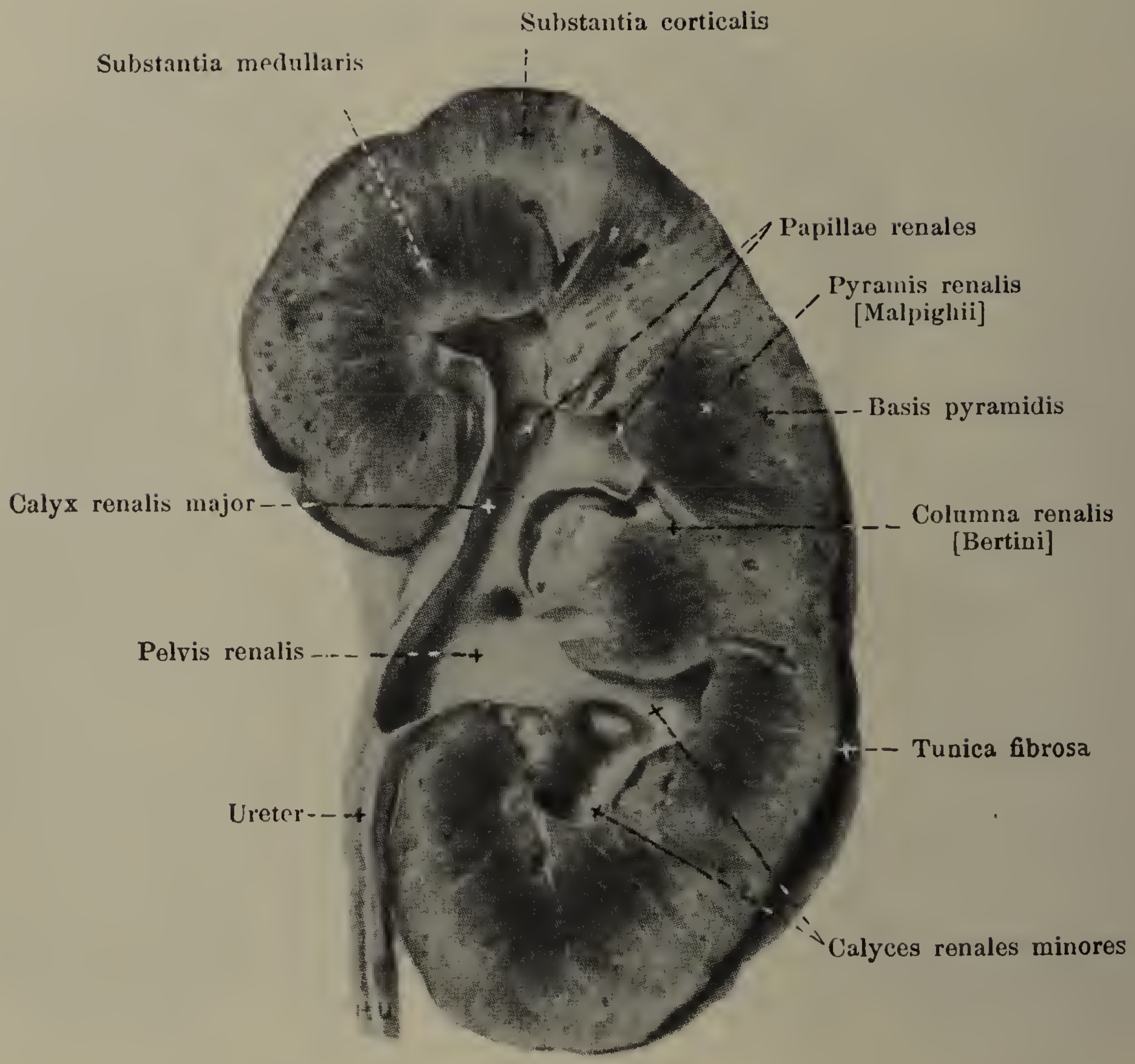
The surface of the kidney is usually smooth and presents notches only at the hilus. In the embryo and the new born (see Fig. 692) it is, on the contrary, subdivided by several deep furrows into a large number of lobes, *lobi renales* (see also p. 598), the margins of which disappear as a rule during the early years of life.

Structure of the kidney (see Fig. 690).

The external covering of the kidney (within the capsula adiposa) is formed by the thin, but firm layer of connective tissue, *tunica fibrosa*, the innermost part of which, *tunica muscularis*, contains a network of smooth muscle bundles; it is easily separable from the underlying tissue. The gland tissue consists of two layers, *substantia medullaris* and *substantia corticalis.*

The *substantia medullaris, medullary substance*, surrounds the sinus renalis and consists of 26 to 46 (averaging 35) wedge-shaped masses, *pyramides renales [Malpighii]*, between which, separating them, are intercalated strips of substantiā corticalis, *columnae renales [Bertini]*. Each pyramis renalis has its rounded *basis pyramidis* directed toward the substantia corticalis; its apex lies in a small blunt wedge-shaped elevation, *papilla renalis*, which projects from the medullary substance into the beginning of a renal calyx (see p. 598). The pyramids present converging stripes toward their apices, converge toward the hilus and fuse at their apices with their neighbors, so that each papilla renalis contains 2—4 (at the poles 5—9) apices of pyramids. The number of papillae renales varies from 6 to 14 (averaging 9).

The *substantia corticalis (cortical substance)* forms the continuous peripheral layer and extends between the pyramids of the medullary layer as the columnae renales (vide supra).



690. Right kidney, cut through, viewed from behind.

Structure of the kidney (continued).

The cortical substance and the columnae renales are of a reddish-brown color, the pyramids are somewhat lighter toward their apices, but elsewhere more violet and darker.

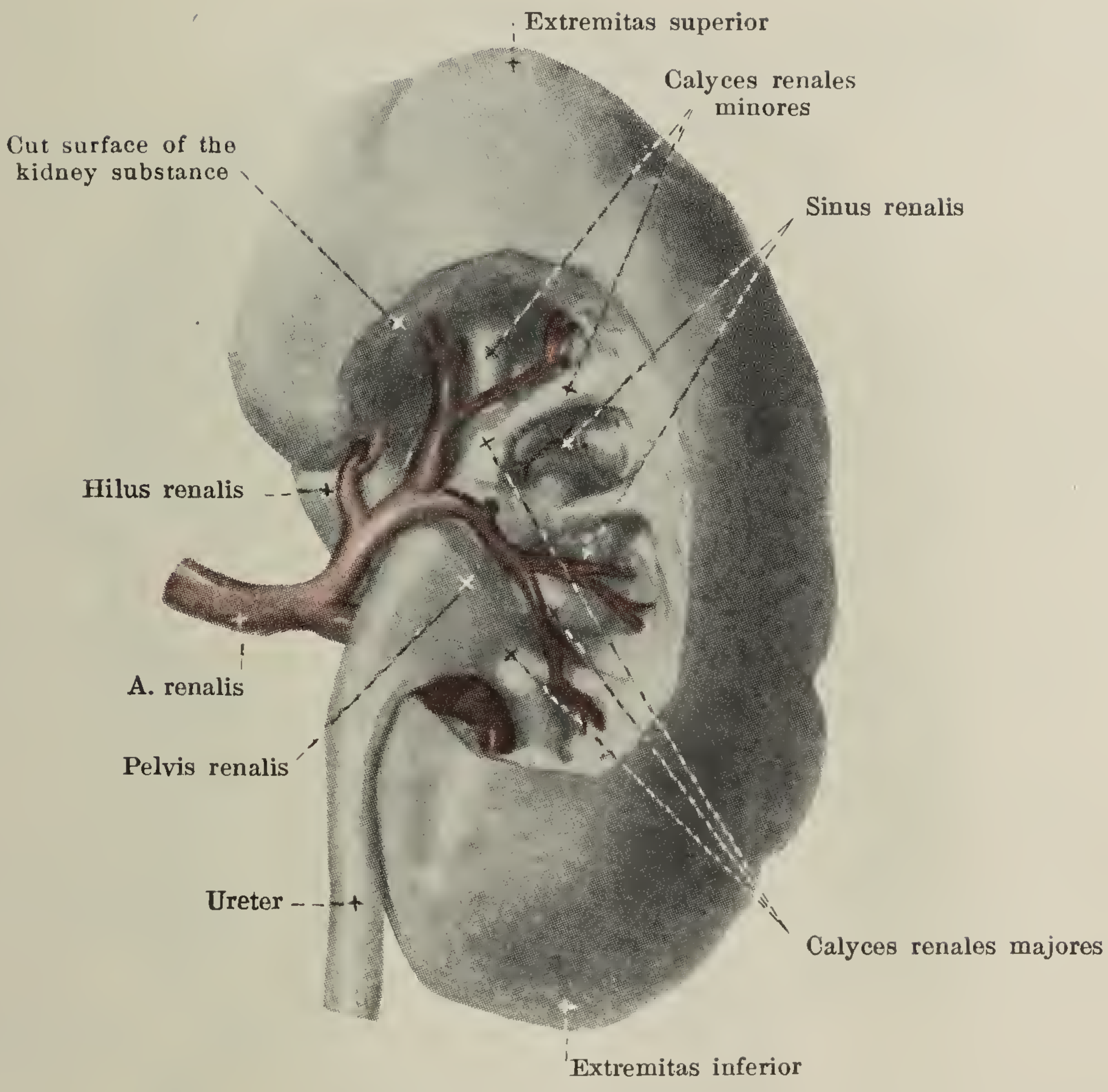
In the fetus and new-born (rarely in the adult) the surface is divided by deep, irregular furrows into 11—21 (averaging 15) areas (see Fig. 692). Each wedge-shaped portion of the cortical and medullary substance reaching as far as the sinus renalis corresponding to one of these areas is called a *lobus renalis;* each renal lobe contains several pyramides renales and is not separable in the depth from its surroundings.

The excretory ducts of the kidney, *urinary tubules, tubuli renales* (not illustrated), in the cortex are in their course partly tortous, *tubuli renales contorti,* partly straight, *tubuli renales recti,* in the pyramids straight only. The cortex consists of an enormous number of very small columnar *cortical lobules, lobuli corticales,* all of which extend from the medullary substance to the periphery, lying closely packed together and only incompletely separable from one another; their margins are indicated by the radially directed aa. and vv. interlobulares renis. In the axis of each lobule extending from the basis pyramidis to the apex is a light strip, *pars radiata [processus Ferreini],* which is formed of tubuli recti; the rest of the lobule, *pars convoluta,* is of a somewhat darker color and consists of tubuli contorti.

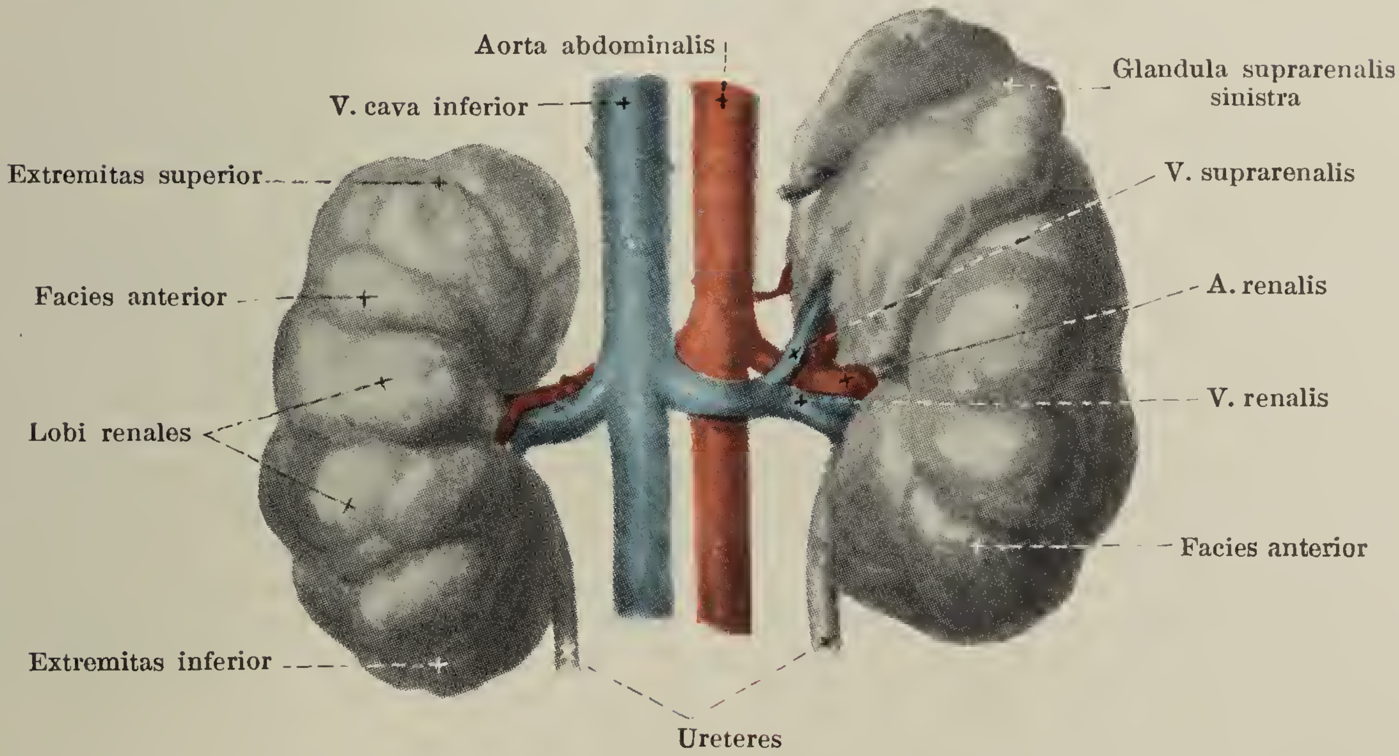
The largest tubuli renales of each pyramid converge toward its apex, open there by *foramina papillaria* into the calyx of the kidney and thus form the *area cribrosa* of the papilla.

Excretory channels of the kidney (see also Fig. 691).

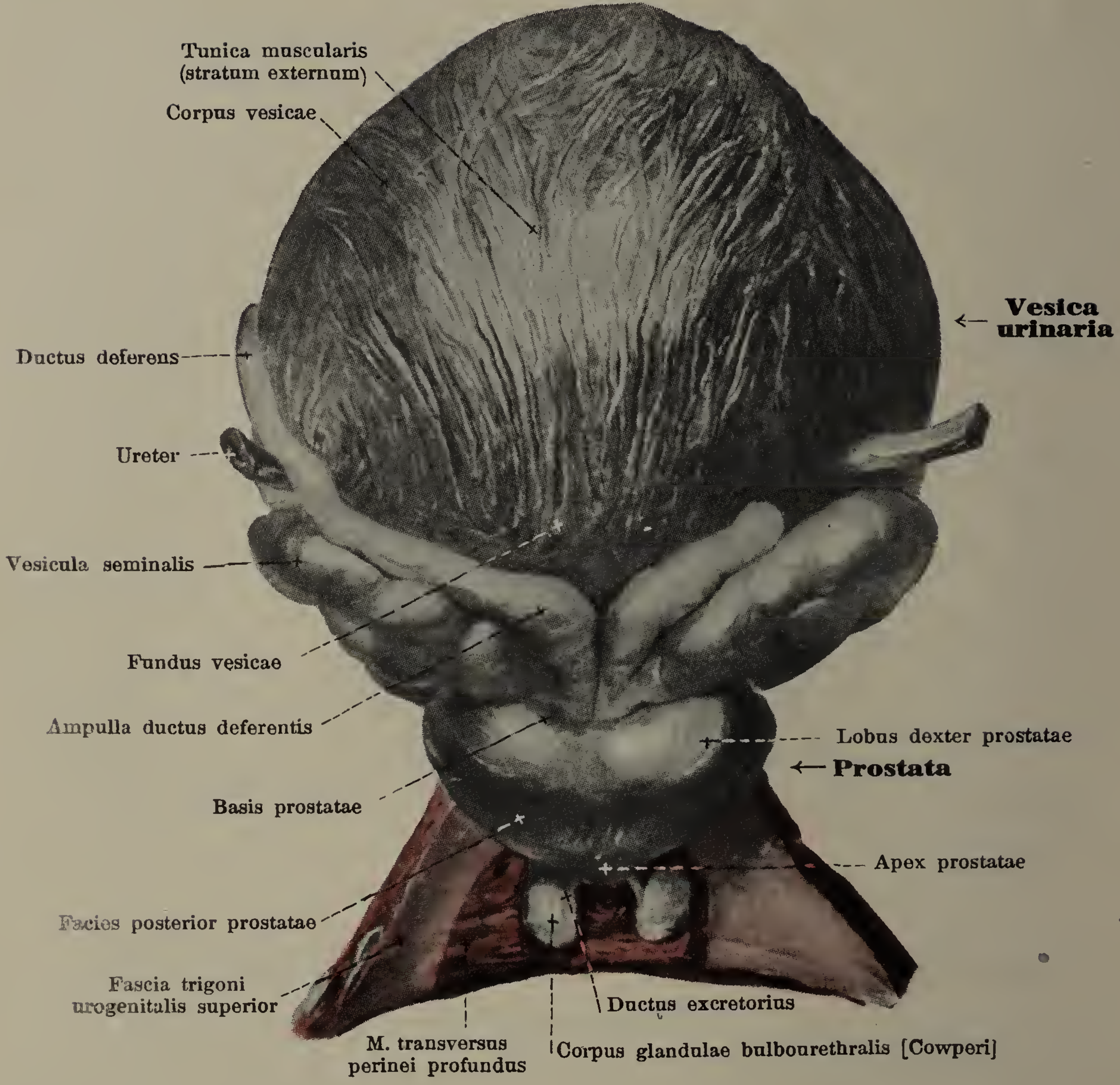
Each papilla renalis projects usually singly into the blind end of a short narrow tube, *calyx of the kidney, calyx renalis minor,* and is covered by its mucous membrane. Several calyces minores unite to form one short, broader *calyx renalis major,* of which there are altogether usually 2 or 3; these again combine and form the *pelvis of the kidney, pelvis renalis,* a flattened tube curved downward and narrowed below, which either gradually or by sudden constriction goes over into the ureter. The calyces renales, with the branches of the blood vessels and some fatty tissue, completely fill up the sinus renalis. The pelvis of the kidney in part projects out of the hilus renalis (see also Fig. 689) and there lies behind the blood vessels surrounded by fatty tissue.



691. Right kidney with its pelvis exposed, viewed from behind.



692. Kidneys of a new-born babe, viewed from in front.
(The left suprarenal gland has been left in position, the right has been removed.)

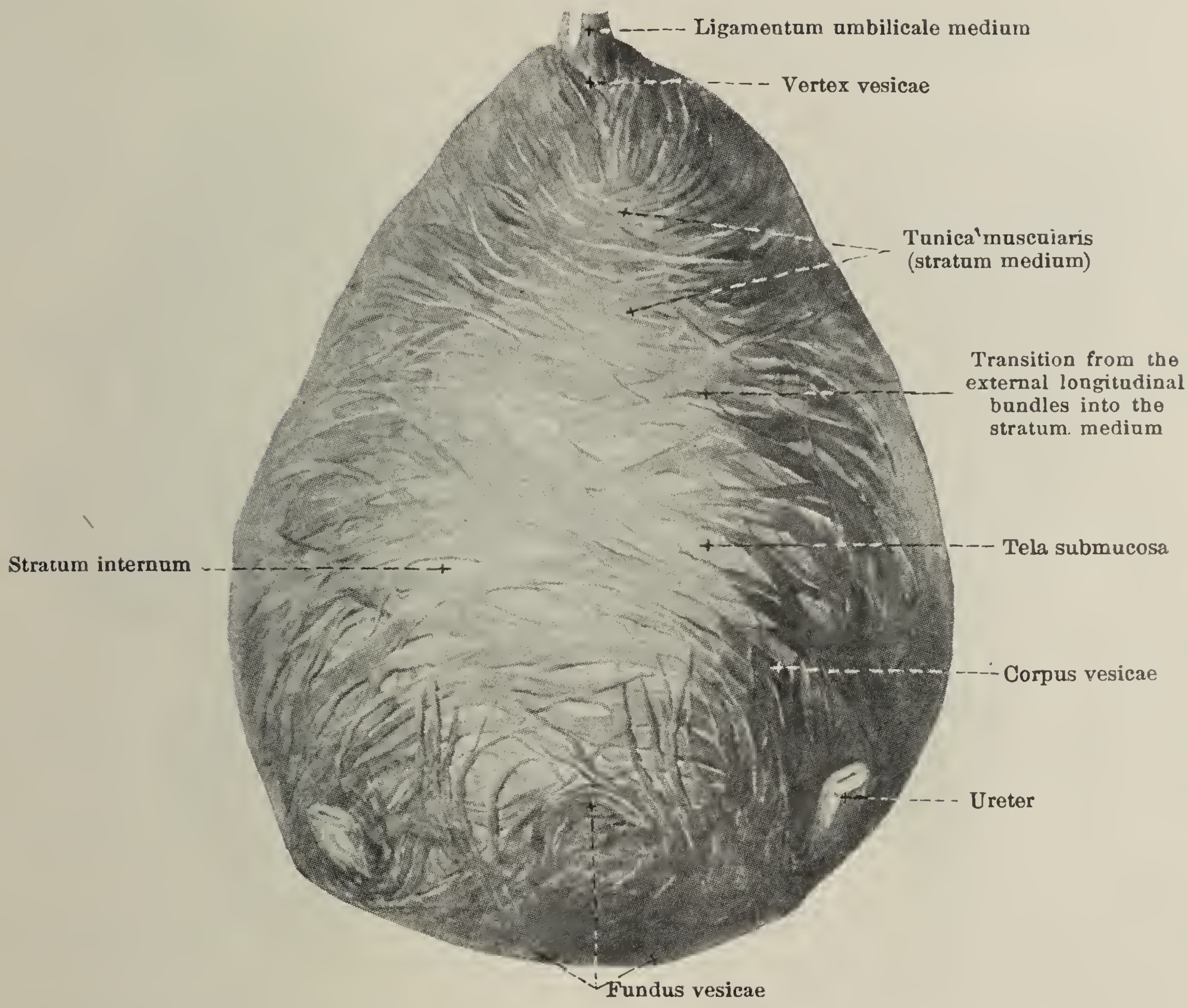

Tunica muscularis (stratum externum)
Corpus vesicae
Vesica urinaria
Ductus deferens
Ureter
Vesicula seminalis
Fundus vesicae
Ampulla ductus deferentis
Lobus dexter prostatae
Prostata
Basis prostatae
Apex prostatae
Facies posterior prostatae
Fascia trigoni urogenitalis superior
Ductus excretorius
M. transversus perinei profundus
Corpus glandulae bulbourethralis [Cowperi]

693. Urinary bladder, distended, with surrounding structures, viewed from behind.

(The glandulae bulbourethrales have been exposed in the trigonum urogenitale.)

The **ureter** (see also Figs. 686, 689, 708, 718—720) runs out on each side from the pelvis of the kidney in front of the m. psoas and the fascia iliaca; it is imbedded in loose connective tissue, is curved slightly downward and a little medianward *(pars abdominalis)*, crosses usually on the right side the a. and v. iliaca externa immediately after their origin (see Figs. 521 and 551), on the left side the a. and v. iliaca communis and then *(pars pelvina)* (see Fig. 521) extends on the medial surface of the a. hypogastrica, usually further forward on the right than on the left, medianward from the a. and n. obturatorius and the a. vesicalis superior (a. umbilicalis) (in the female at the same time directly behind the margo liber of the ovary, see Fig. 718 and 719), downward on the lateral wall of the small pelvis; from there on it behaves somewhat differently in the two sexes. The pars abdominalis above lies behind the pars descendens duodeni on the right side, behind the flexura duodenojejunalis on the left side, is then crossed in front by the a. and v. spermatica interna and is everywhere retroperitoneal in position. The pars pelvina is also, for the most part, directly covered by peritonaeum. In the male its terminal portion (see Figs. 686 and 708) extends from the lateral wall of the pelvis, medianward and somewhat forward near the upper end of the vesicula seminalis to the fundus vesicae and in so doing is crossed medianward and in front by the ductus deferens. In the female (see Figs. 522, 523, 553, 718—720), where the terminal portion lies on the medial side of the a. uterina on the pelvic wall, it turns forward and medianward below the posterior layer of the ligamentum latum uteri to the base of the urinary bladder; in so doing, it runs through the parametrium, about 1½ cm lateral from the cervix uteri, then comes into direyt contact with the anterior and lateral wall of the vagina, being crossed in front by the a. uterina at the level of the orificium internum uteri.

The ureter enters the urinary bladder, passing obliquely forward and medianward, runs for some distance in the wall of the same, and then opens at the orificium ureteris (see Figs. 695 and 696).



694. Urinary bladder, distended,

after removal of the superficial muscular layer, viewed from behind and above.

Ureter (continued).

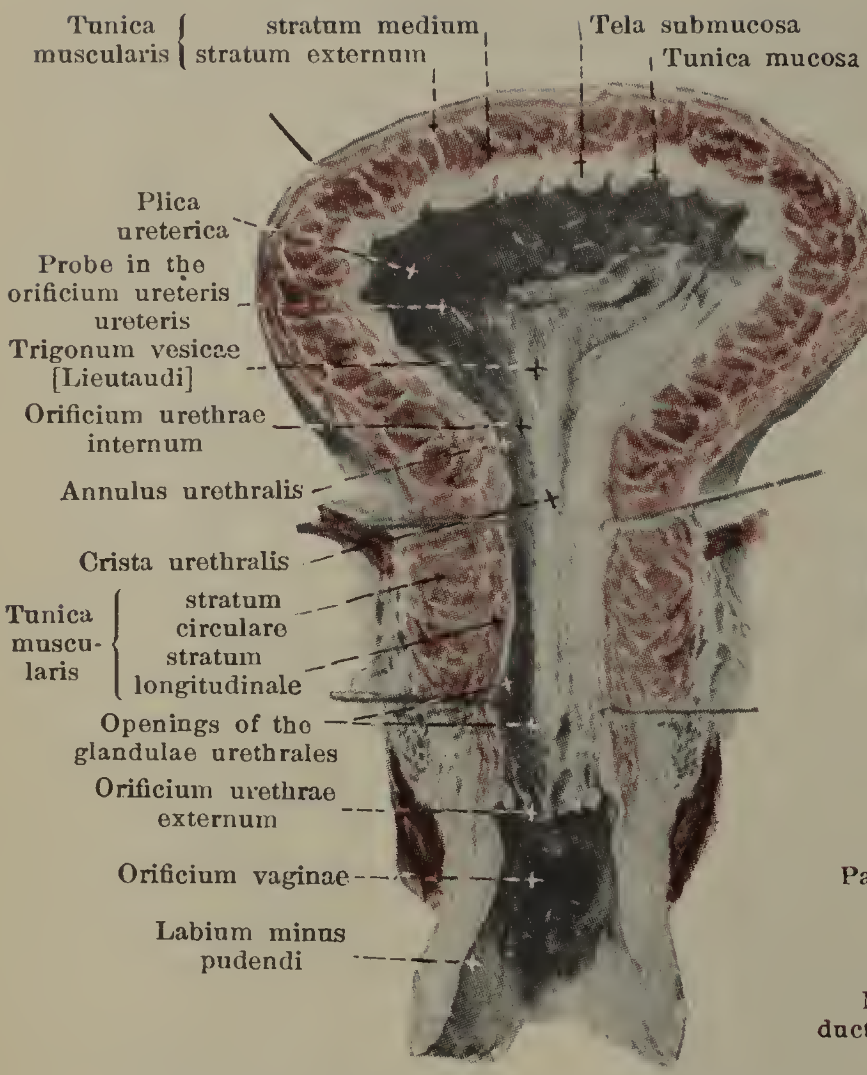
The ureter is a tube, flattened from before backward, which, in the lower part of its pars abdominalis, presents a spindle-shaped dilatation of variable length, the lower boundary of which is situated in front of the a. iliaca. The pars pelvina is of approximately even caliber throughout.

The *wall of the ureter* (not illustrated) consists of a peripheral *tunica adventicia*, composed of connective tissue, a thick muscular layer, *tunica muscularis*, in which are distinguishable a middle circular layer, *stratum medium*, as well as an external, longitudinal layer, *stratum externum* (existing only in the lower half), and an internal longitudinal layer, *stratum internum*, and the mucous membrane, *tunica mucosa*.

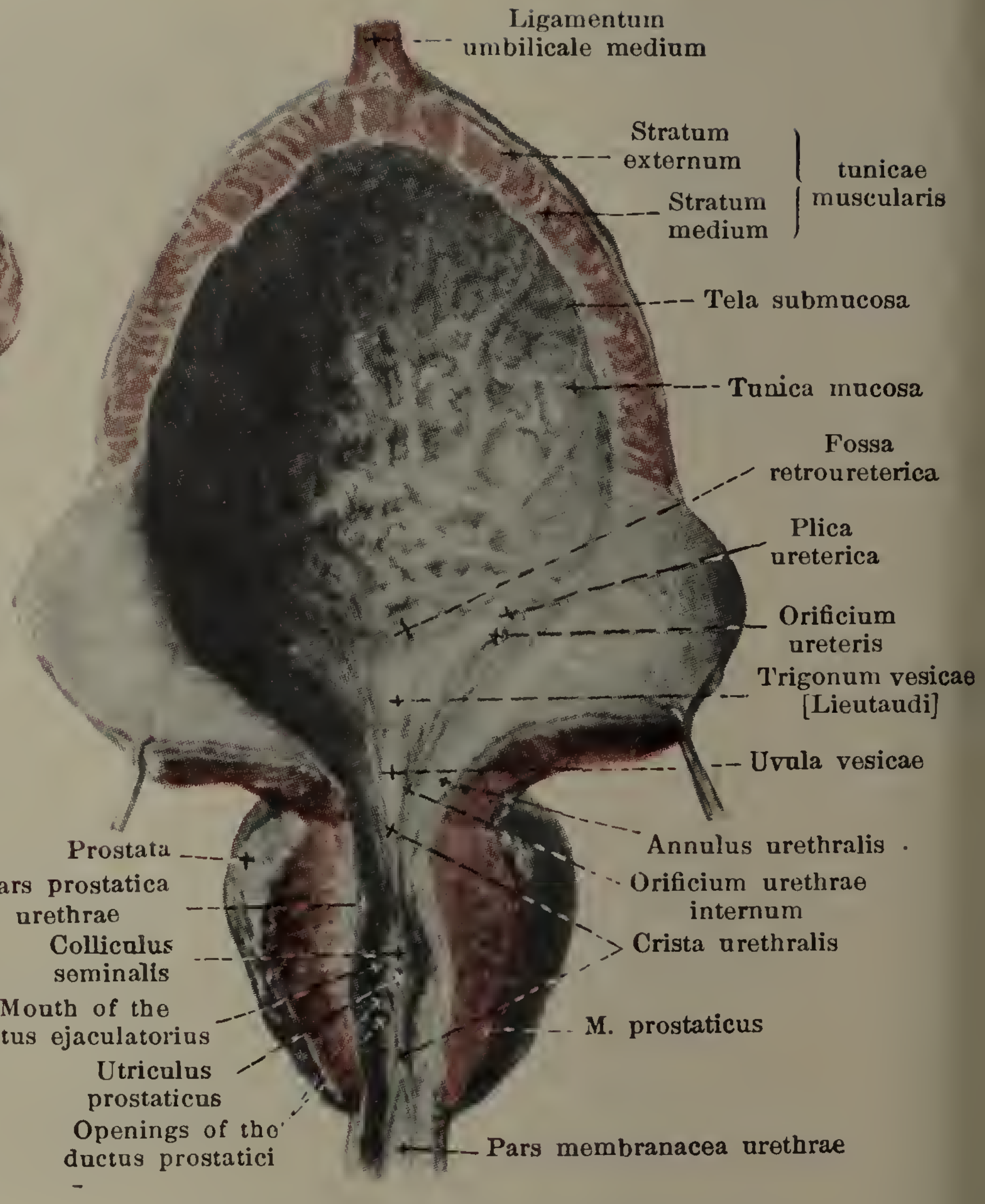
The **urinary bladder**, *vesica urinaria* (see also Figs. 686, 693, 695, 696, 708, 709, 718, 719 and 730), is an unpaired, musculo-membranous sac, situated in the small pelvis, into which open the right and the left ureter; it communicates with the urethra through the orificium urethrae internum.

It presents for examination a *vertex vesicae* or *vault of the bladder* directed forward and upward; in youth this has the shape of a blunt wedge. Extending upward from the vertex to the navel is a cord of connective tissue, *ligamentum umbilicale medium* (see p. 567), the remnant of the obliterated embryonic urachus. The inferior and posterior region turned toward the perineum, containing the orificium urethrae internum, the trigonum vesicae and the plicae uretericae, is the *fundus vesicae*. The rest is called the *body of the bladder*, *corpus vesicae*.

The *form* of the empty bladder (see Figs. 693, 708, 709, 718 and 719) is similar a tetrahedron, the four corners being formed by the beginning of the lig. umbilicale medium, the entries to the ureters in the urinary bladder and by the urethra; the margins are rounded off and the surfaces slightly convex; the bladder when full is egg-shaped or spherical. Deviations in shape are not unusual. The more tube-like or pear-shaped form met with in childhood may be found even in the adult. In all cases the contracted bladder has a thicker wall than the relaxed bladder, and the wall is thicker in the male than in the female.



695. Urinary bladder in the female, contracted, opened from in front.



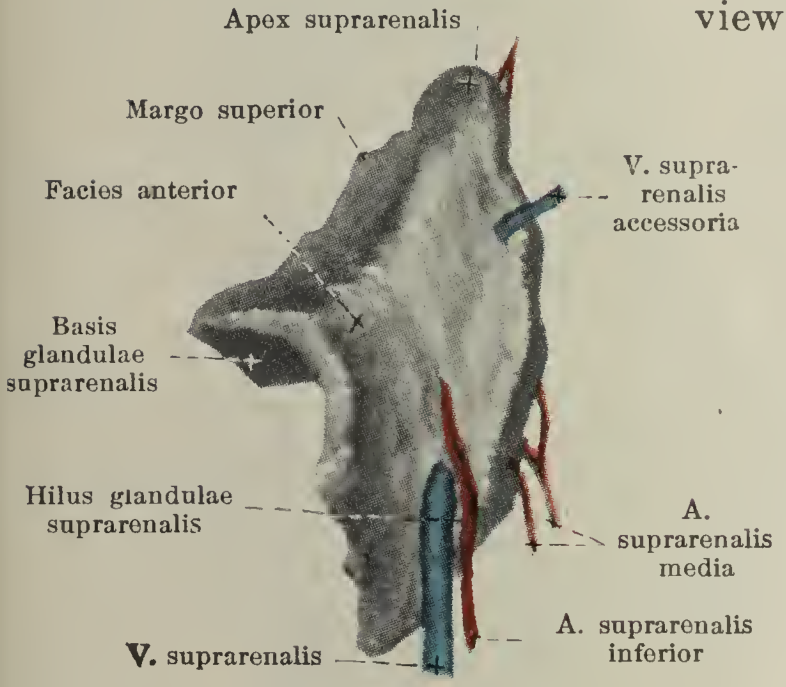
696. Urinary bladder in the male, moderately distended, opened from in front.

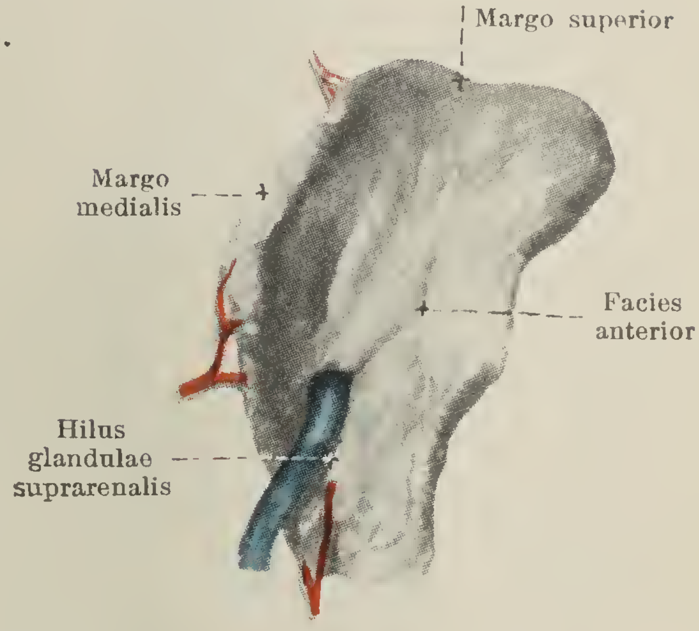
Wall of the urinary bladder (see also Figs. 693, 694, 708, 709, 718, 719, 729 and 730). It is partly covered by a peritoneal coat, *tunica serosa.* This covers the upper wall and the upper part of the lateral surface (in the male also the upper part of the posterior wall, reaching somewhat deeper in the middle); it turns in the female upon the facies vesicalis uteri, in the male upon the anterior surface of the rectum usually somewhat above the basis prostatae. The peritonaeum forms a transverse fold, *plica vesicalis transversa* (see p. 615), over the empty bladder. The second layer, *tunica muscularis,* consists of smooth muscle fibres, which are arranged in the form of a network. Its *stratum externum* (see Fig. 693) is formed of bundles which are very narrow-meshed especially in the middle; the bundles run in a longitudinal direction and diverge somewhat toward the vertex; in front they are connected with the *m. pubovesicalis* (see p. 633), behind with the *m. rectovesicalis* (see p. 615). The *stratum medium* (see Fig. 694) is the strongest; its bundles run especially in the transverse direction, form an uninterrupted layer at the fundus and there go over into fibres which surround the urethra in a ring inclined obliquely forward and downward, the *m. sphincter vesicae,* and are connected in front with the m. prostaticus. The *stratum internum* is thin and consists of wide meshes somewhat drawn out in the longitudinal direction. All three layers are intimately connected with one another, since bundles from one go over into the others. The tunica muscularis is separated by the vascular *tela submucosa* from the mucous membrane, *tunica mucosa.* The latter, of an intense red color, presents, when the bladder is empty or moderately filled, numerous folds which vanish when the organ is distended. Situated at the fundus vesicae is an approximately triangular smooth area (or when the bladder is empty not quite smooth), *trigonum vesicae [Lieutaudi].* This is bounded behind on each side by the *plica ureterica,* a flat projection which is bulged forward by the ureter on its passage through the wall of the bladder and which in front contains the obliquely situated *orificium ureteris.* In front the trigonum reaches as far as the sickle-shaped *orificium urethrae internum,* which is convex forward forming a small oblong rounded elevation, *uvula vesicae.* The orificium urethrae internum is surrounded by a circular projection, *annulus urethralis,* which is especially distinctly developed in the male and which surrounds also the initial portion of the urethra.

697. Right suprarenal gland,

698. Left suprarenal gland,

viewed from in front.



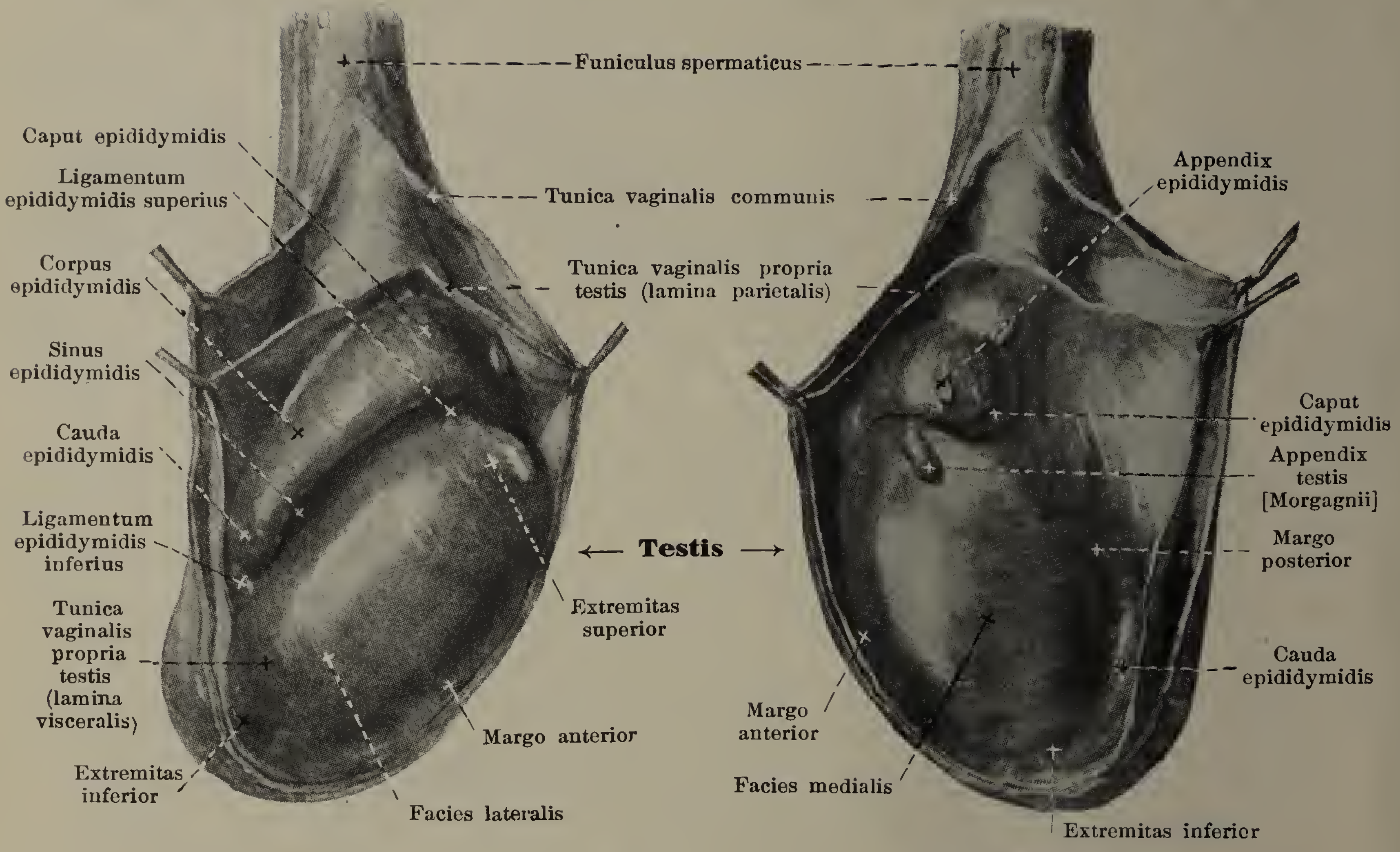


Position of the urinary bladder (see Figs. 686, 708, 709, 718-720 and 730). The anterior wall, looking at the same time downward, lies just behind the symphysis ossium pubis and the neighboring parts of the pubic bone, separated from them above by loose tissue only, below also by the plexus pudendalis (see Figs. 551 and 553). When the bladder is empty the vertex does not project beyond the upper margin of the symphysis; when it is full it projects above it for a variable distance. The lateral wall, turned at the same time downward, is very narrow when the bladder is empty and lies against the m. levator ani (see Fig. 730); when the bladder is full it passes upward on the m. obturator internus and is crossed by the a. umbilicalis (ligamentum umbilicale laterale) and the ductus deferens (in the male, ligamentum teres uteri in the female) (see Fig. 708); it is separated from the muscles by loose tissue, the fascia pelvis and the plexus vesicalis (see Figs. 551, 553 and 730). The inferior wall of the urinary bladder adjoins in the male the basis prostatae, in the female the trigonum urogenitale; its deepest point is usually the orificium urethrae internum, which in the male is situated behind the middle of the symphysis ossium pubis or somewhat higher, in the female is situated somewhat deeper. The posterior wall, directed at the same time somewhat downward, is in relation in the male with the seminal vesicles, with the ampullae of the seminal ducts, as well as, between and above these in variable extent and separated from it by loose tissue, with the rectum; above it is covered by peritonaeum. In the female it rests upon the anterior wall of the vagina and is connected with it and the cervix uteri by loose tissue rich in veins. On the upper wall, covered by peritonaeum, in the male lie intestinal loops; in the female the facies vesicalis of the uterus lies upon it, separated from it only by the slit-like excavatio vesicouterina. The bladder, when full, projects for a variable distance upward into the peritoneal cavity. By distension of the rectum the orificium urethrae internum is pressed forward and upward so that the bladder when it becomes full at the same time lies directly in contact for some distance with the anterior abdominal muscles.

The **suprarenal glands,** *glandulae suprarenales* (see also Figs. 686 and 692), are two small flat bodies, which lie directly medial from and above the kidneys, one on each side. The right is approximately triangular and sits more upon the upper pole of the kidney, the left approximately sickle-shaped and lies more upon the margo medialis of the kidney. Each presents for examination a posterior surface, *facies posterior*, which lies loosely upon the pars lumbalis diaphragmatis, and a *facies anterior,* which is in relation on the right side with the impressio suprarenalis hepatis (there covered below by peritonaeum) and the v. cava inferior, on the left side above with the pars cardiaca of the stomach (thus far covered also by the posterior layer of the bursa omentalis), below with the a. and v. lienalis and the pancreas; on the anterior surface runs a groove, *hilus glandulae suprarenalis,* from which the principal vein, *v. centralis,* emerges. The concave *basis glandulae suprarenalis* looks lateralward and backward and lies upon the kidney. In addition there can be made out a sharpened *margo medialis* and *margo superior,* which form on the right an obtuse angle, *apex suprarenalis.* The left margo superior is in contact with the facies renalis of the spleen. The suprarenal gland consists of a firmer yellowish *substantia corticalis* which develops from coelomic epithelium of the embryo and of a softer brownish *substantia medullaris* which arises from sympathetic elements.

Real **accessory suprarenal glands,** *glandulae suprarenales accessoriae* (not shown), consisting of cortical and medullary substance are very rarely seen in the adult and when present are to be found in the plexus nervosus coeliacus.

Other accessory suprarenals, of cortical substance only, are very common; they are found in varying numbers in the neighborhood of the suprarenal glands, also in the kidneys, liver, pancreas, near the sexual glands and along the vasa spermatica interna.



699 and 700. Right testicle and epididymis

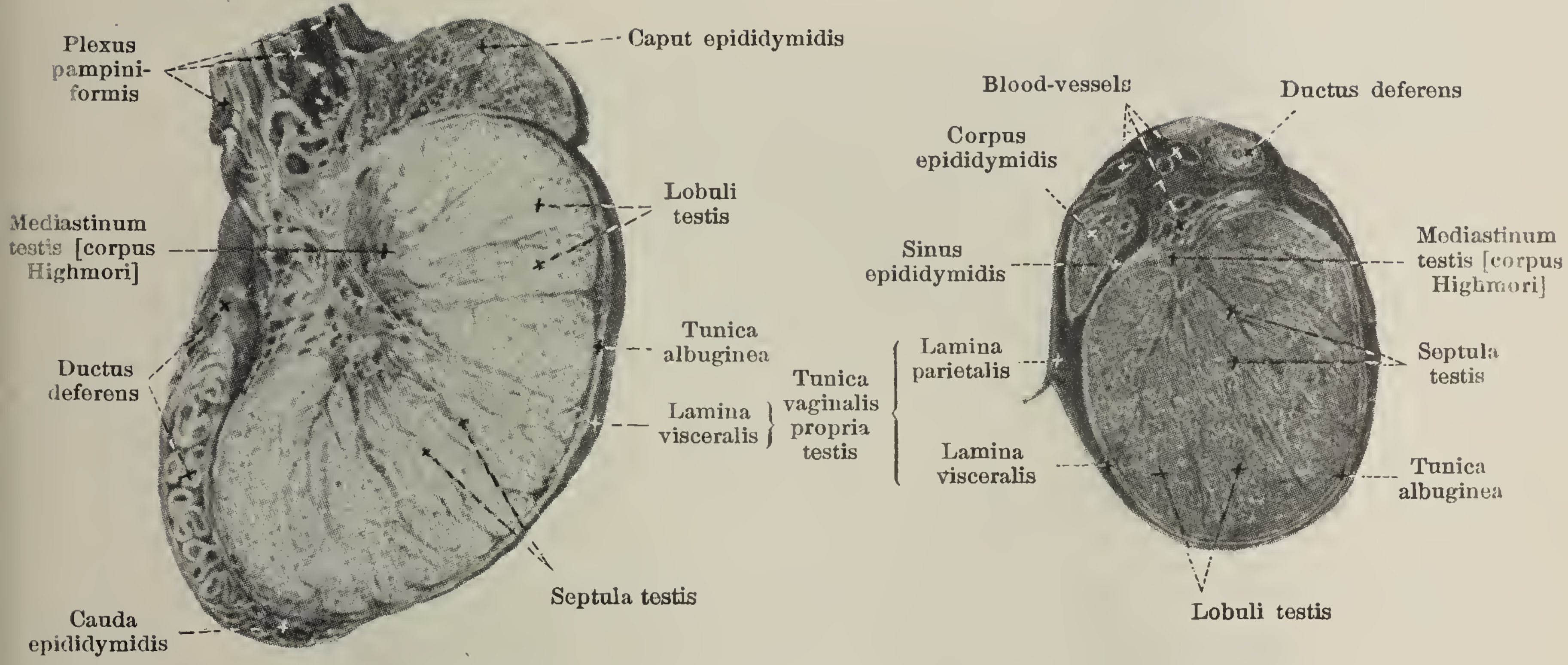
after opening the ensheathing membranes,

viewed from the lateral surface, viewed from the medial surface.

The **testicles,** *testes,* are the two male sexual glands which secrete the *sperma [semen];* they lie in the lower portion of the scrotum (see Fig. 705) and each possesses an appendage, the *epididymis.*

The ***testicle,*** *testis* (see also Figs. 701 and 702), is approximately egg-shaped, flattened somewhat from side to side and presents a convex surface of a bluish-white color. Its upper *pole, extremitas superior,* is directed at the same time somewhat forward and lateralward; its lower pole, *extremitas inferior,* is directed at the same time somewhat backward and medianward. It presents also a slightly convex *facies lateralis,* which looks at the same time somewhat backward, and a more flattened *facies medialis,* which is directed at the same time somewhat forward; these surfaces are connected with one another by a free *margo anterior,* which is directed at the same time a little downward, and the hidden *margo posterior* which looks also upward and at which the vessels and nerves enter and leave the testicle.

Structure of the testicle (see also Figs. 701—704). The surface of the testicle with the exception of the margo posterior is smooth and glistening, being formed by the *lamina visceralis* of the *tunica vaginalis propria testis* (see p. 608). Beneath it, fused with it, lies the *tunica albuginea.* This tough membrane of connective tissue completely ensheaths the substance of the testicle and is thickened at the posterior margin to form a triangular projection of loose sponge-like porous structure which extends into the interior of the testicular substance and is called the *mediastinum testis [corpus Highmori].* Radiating out from this like a fan are thin leaflets of connective tissue, interrupted in spots, *septula testis;* these unite with the peripheral tunica albuginea. In the connective tissue framework lies the *parenchyma testis.* This consists of the approximately wedge-shaped lobules of the testicle, *lobuli testis* (100—200), which are separated from one another by the septula; the lobules converge with their apices toward the mediastinum testis. Each lobule contains two or more long, manifoldly twisted seminal canals which begin in part blind in the periphery and may anastomose with one another, *tubuli seminiferi contorti.* They unite at the apex of the lobule to form short, narrow, straight seminal canals, *tubuli seminiferi recti,* which enter the mediastinum testis and form in it along with the others a fine network, *rete testis [Halleri].* Out of this network proceed about a dozen (7—15) *ductuli efferentes testis,* which perforate the tunica albuginea at the upper end of the posterior margin and enter the head of the epididymis.



701 and 702. Right testicle and epididymis.

Sagittal section. Transversal section.

The ***epididymis*** (see also Figs. 699, 700, 703 and 704) is long, cordlike, and sits upon the posterior margin of each testicle; it is curved so as to be convex backward and at the same time lateralward. Its upper, somewhat thicker portion, *caput epididymidis*, is directed medianward with its rounded end, rests with its lower concave surface upon the upper pole of the testicle and in largest part is there fused with it. The approximately triangular middle piece, *corpus epididymidis*, lies with its concave anterior surface upon the posterior margin and the posterior portion of the lateral surface of the testicle; it is partly separated from it by the sinus epididymidis, otherwise fused with it. The lower, rounded end, *cauda epididymidis*, goes over below with a sharp bent into the beginning of the ductus deferens, which extends upward and backward.

Structure of the epididymis (see also Figs. 699, 700, 703 and 704). The slightly nodular surface is covered on the convex side of the caput, on the lateral and partly also on the anterior surface of the corpus and on the lateral surface of the cauda by the *lamina visceralis* of the *tunica vaginalis propria testis* (see p. 608). Between the testicle and the corpus epididymidis this membrane therefore gives rise to a slit-shaped prolongation of variable length, *sinus epididymidis*, which is bounded above and below by variably developed folds, *ligamentum epididymidis superius* and *ligamentum epididymidis inferius* respectively. The caput epididymidis consists of about a dozen (7—15) small wedge-shaped lobules, *lobuli epididymidis;* each of these has its base directed toward the free surface and receives at its apex one ductulus efferens testis, which forms a skein and by numerous turns completely fills up the lobule. The ductulus of the uppermost lobule goes from the base of the same, markedly twisted; to the corpus epididymidis, receives the ducts of the other lobules and becomes the *ductus epididymidis*. This completely fills up the corpus and the cauda epididymidis with its numerous short and marked turns and is continued at the end of the cauda directly into the ductus deferens.

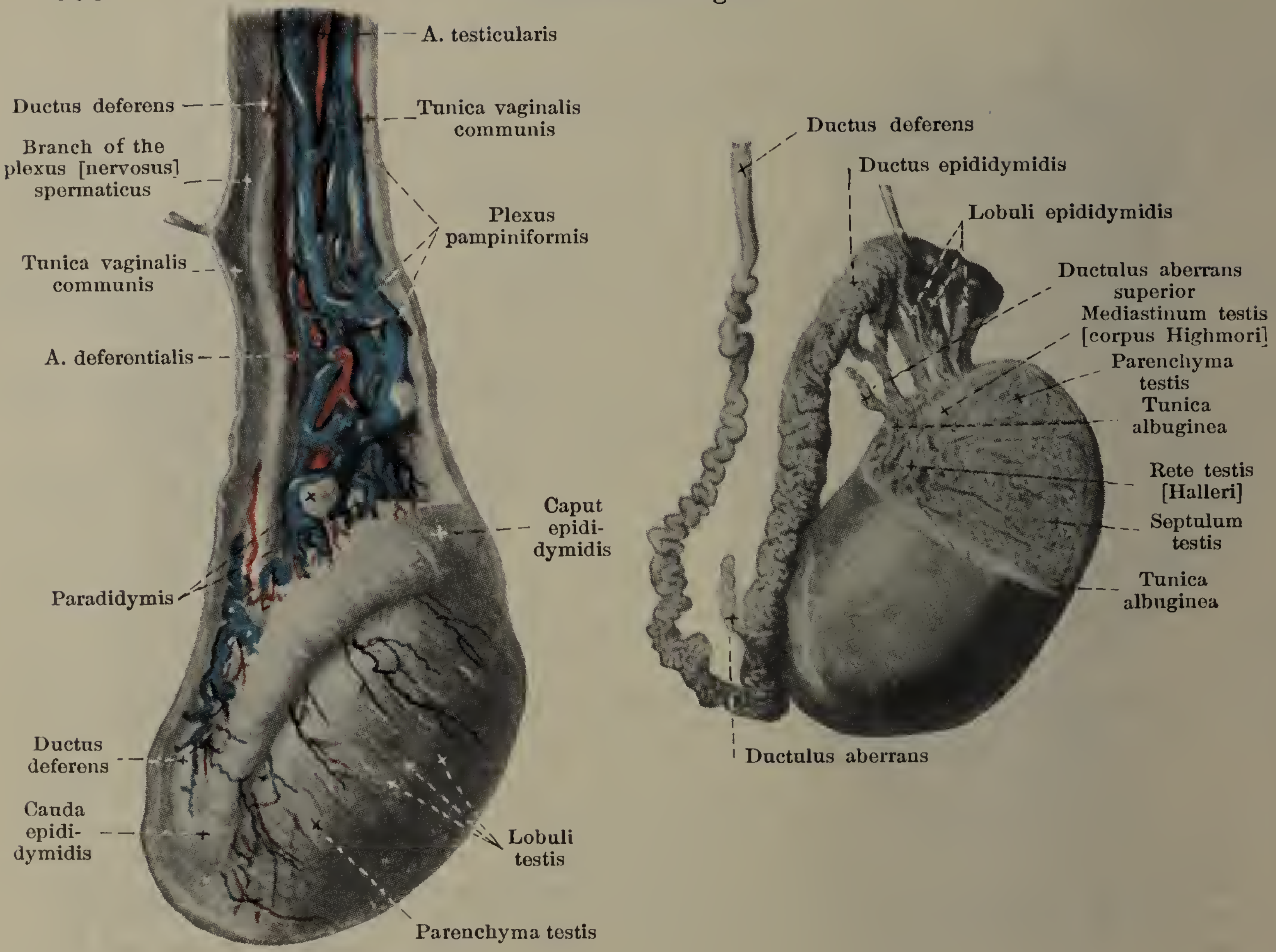
Appendages of the testicle and epididymis, appendices testis (see Figs. 699 and 700).

Appendix testis [Morgagnii], non-pedunculated hydatid, constant, sits as a soft, oblong corpuscle with a broad base upon the upper pole of the testicle, just beneath the caput epididymidis. It is a remnant of the upper end of Müller's duct, homologous with the infundibulum tubae uterinae.

Appendix epididymidis, pedunculated hydatid, single or multiple, connected frequently with the free end of the caput epididymidis as a small pedunculated pear-shaped vesicle. It consists of the stunted abdominal end of the Wolffian duct or of remains of canals of the Wolffian body.

Ductuli aberrantes (see Fig. 704) are tortuous ducts ending blind, in the epididymis. The *ductulus aberrans superior,* in the caput epididymidis, is connected with the rete testis. The other, larger, in the cauda epididymidis, arises from the ductus epididymidis, runs upward for a variable distance; it is a canal of the Wolffian body which has persisted.

Paradidymis (O. T. organ of Giraldés) (see Fig. 703) lies as an oblong body in the lowermost end of the spermatic cord, in front of the vessels. It consists of groups of microscopic vesicles and tubules which are remains of the caudal part of the Wolffian body.



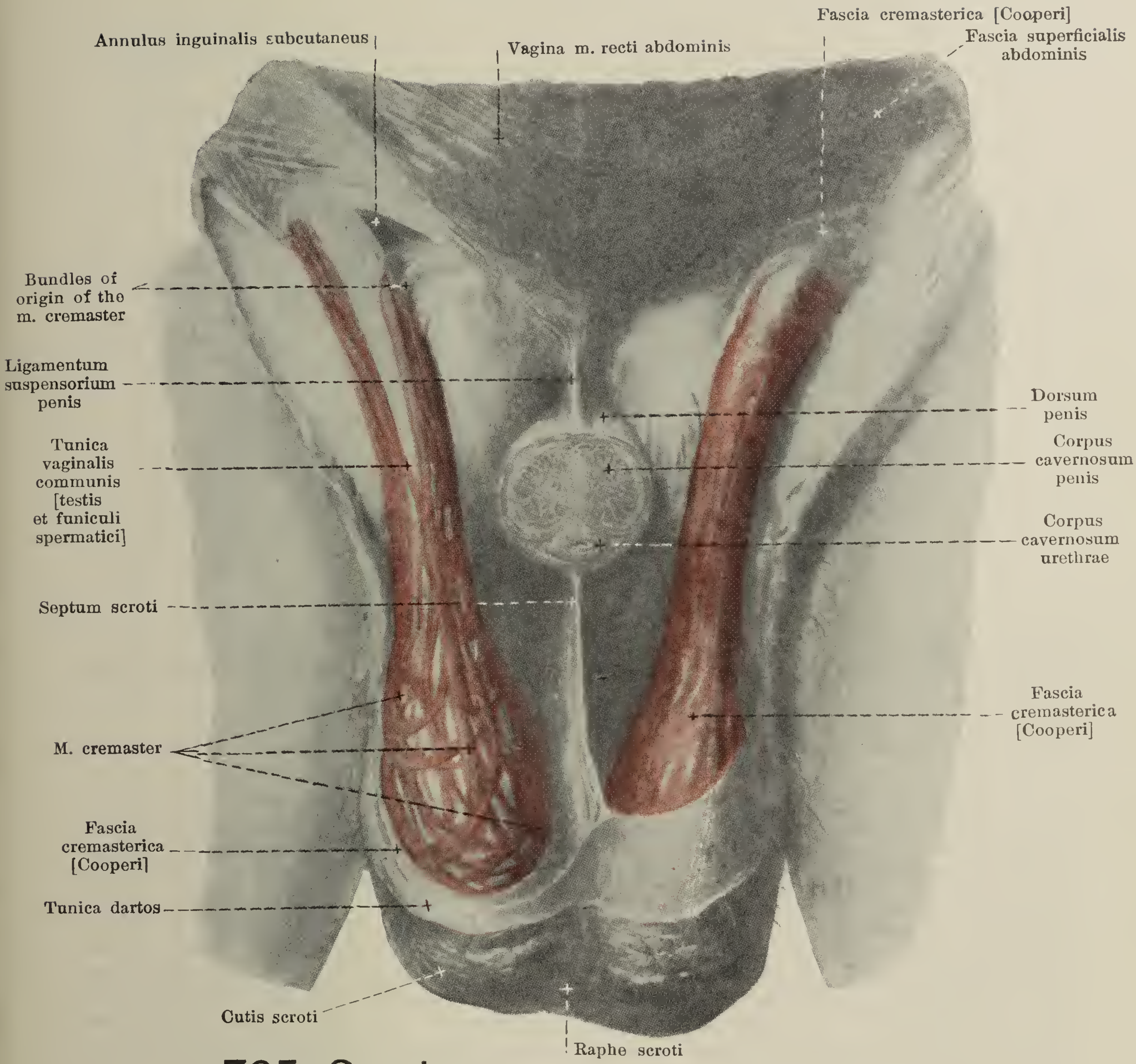
703 and 704. Right testicle and epididymis,
viewed from the lateral surface,

after removal of the tunica albuginea and dissection of the spermatic cord.

after removal of a sector from the testicle and dissection of the epididymis.

The **seminal duct,** *ductus deferens* (see also Figs. 650, 686, 693, 706, 707 and 709), is the excretory duct of the testicle. It begins at the cauda epididymidis as the continuation of the ductus epididymidis and ends by uniting with the ductus excretorius of the seminal vesicle to form the ductus ejaculatorius. It runs upward at first in a markedly tortuous direction, then less tortuously, its wall gradually increasing in thickness, on the posterior margin of the testicle and on the medial surface of the epididymis; it then extends as a rounded, thick-walled, hard cord almost straight upward in the posterior portion of the spermatic cord (turning gradually from its medial to its lateral side) and, passing through the canalis inguinalis lying directly on its inferior wall and arrives in the peritoneal cavity. There it loops over the origin of the a. and v. epigastrica inferior (see Figs. 521, 551, 650 and 686) medianward and runs downward and backward on the lateral wall of the small pelvis; the a. and v. iliaca externa, the ligamentum umbilicale laterale, the vessels and nerves of the neighboring pelvic wall and the ureter lie on its lateral surface in this portion of its course. It then turns medianward to the hind wall of the bladder and extends at first directly over the upper end of the seminal vesicle, then on the medial surface of the same, close behind the wall of the bladder, to the basis prostatae; the ducts of the two sides converge in this part of their course. This last portion situated behind the bladder is markedly curved and presents a spindle-shaped dilatation, *ampulla ductus deferentis,* with a nodular surface; it contains a tortuous main duct and in the interior shows depressions, the *diverticula ampullae,* separated by projecting ridges. From the annulus inguinalis abdominalis as far as the middle of the ampulla, the duct lies directly beneath the peritonaeum.

The wall of the ductus deferens consists of three layers. Externally lies a *tunica adventicia,* which consists of connective tissue. Then follows the *tunica muscularis,* which is composed of a thin, longitudinal *stratum internum,* present only at the beginning, a thick, circular *stratum medium* and a correspondingly thick longitudinal *stratum externum.* Innermost lies the mucous membrane, *tunica mucosa,* partly thrown up in folds.

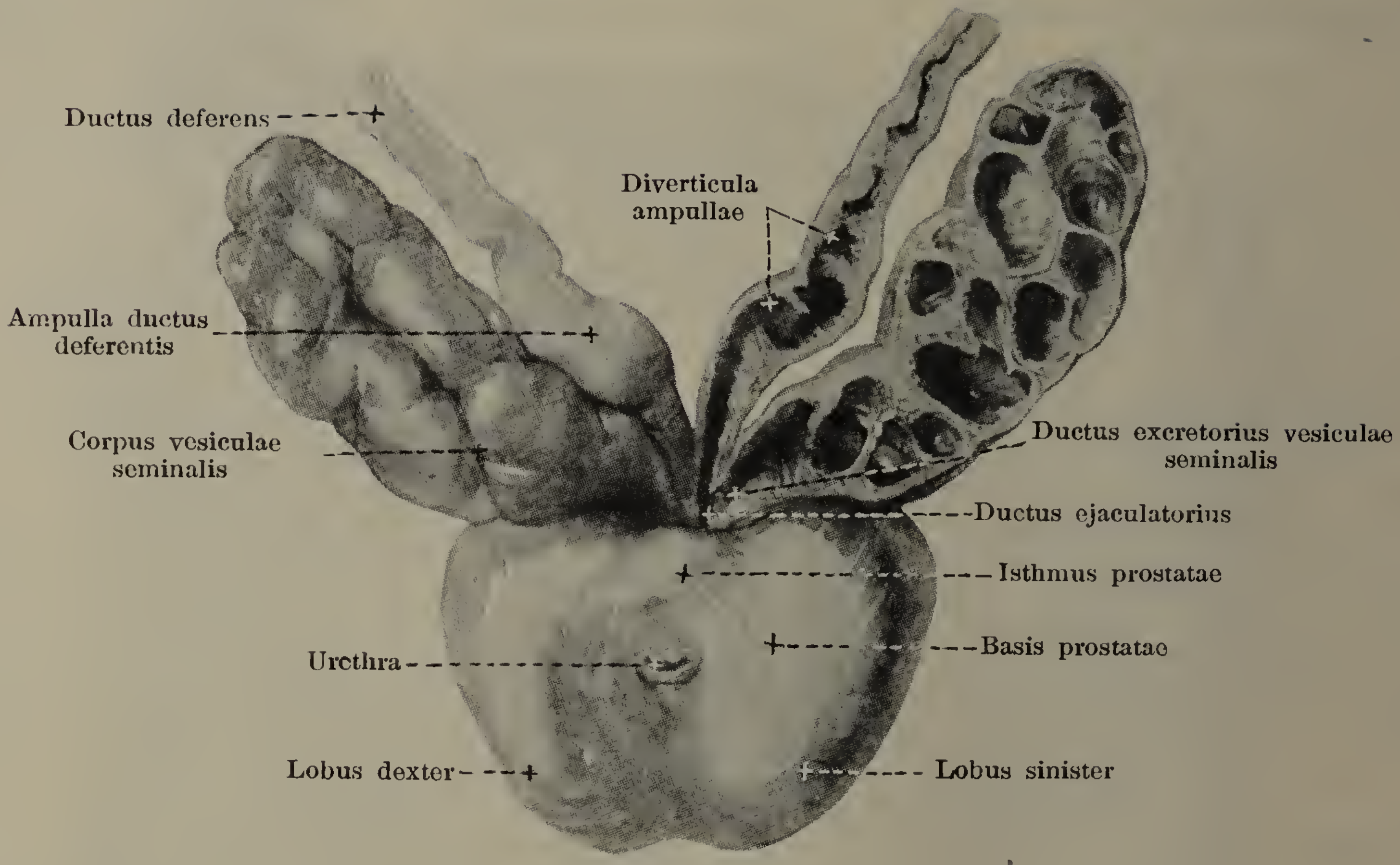

Annulus inguinalis subcutaneus
Vagina m. recti abdominis
Fascia cremasterica [Cooperi]
Fascia superficialis abdominis
Bundles of origin of the m. cremaster
Ligamentum suspensorium penis
Tunica vaginalis communis [testis et funiculi spermatici]
Septum scroti
M. cremaster
Fascia cremasterica [Cooperi]
Tunica dartos
Cutis scroti
Raphe scroti
Dorsum penis
Corpus cavernosum penis
Corpus cavernosum urethrae
Fascia cremasterica [Cooperi]

705. Scrotum, opened, viewed from in front.

(On both sides the skin and the tunica dartos have been removed. On the right side the fascia cremasterica [Cooperi] and the fascia superficialis abdominis have also been removed. The penis has been cut through transversely.)

The **spermatic cord,** *funiculus spermaticus* (see also Figs. 686, 697, 703), is a round, smooth, soft cord from the annulus inguinalis abdominalis to the posterior margin of the testicle.

It contains the ductus deferens, the a. and vv. deferentiales, the a. testicularis, the plexus pampiniformis, lymph vessels, the plexus nervosi deferentialis and spermaticus, as well as (when present) the rudimentum processus vaginalis (see p. 608), all united by loose connective tissue. These structures are all ensheathed by the *common sheath*, composed of connective tissue, *tunica vaginalis communis [testis et funiculi spermatici]*, which may be looked upon as a continuation of the fascia transversalis abdominis. It is very loose and cannot be dissected out in the inguinal canal and does not become tougher until the neighborhood of the testicle and epididymis is reached. It also completely encloses the two latter and is firmly fused with the lamina parietalis of the tunica vaginalis propria testis (see p. 608), as well as with the posterior margin of the testicle and epididymis. In the inguinal canal the fibres of the *m. cremaster* (see p. 299) lie upon this sheath and accompany it downward. In the same layer, in the inguinal canal, lie also the a. and v. spermatica externa and the nn. spermaticus externus and ilioinguinalis. Around these parts at the annulus inguinalis subcutaneus is situated a continuation of the fascia superficialis abdominis, the *fascia cremasterica [Cooperi]*, which is usually distinct above only.



706. Prostate with seminal vesicles and seminal ducts, viewed from in front and above.

(The prostate has been separated from the urinary bladder; on the left side seminal vesicles and seminal ducts have been cut open.)

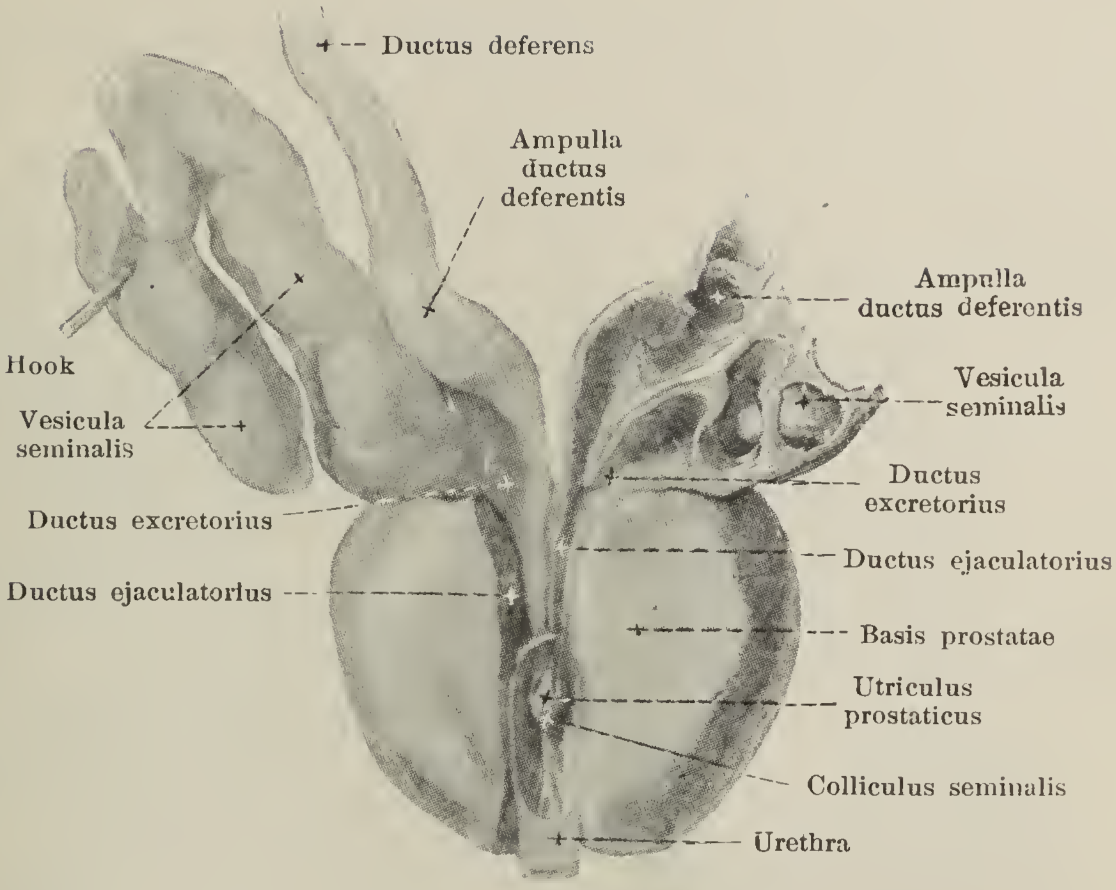
The *proper sheath of the testicle, tunica vaginalis propria testis* (see Figs. 649, 699, 700 and 702), is the serous covering of the testicle and epididymis (see pp. 604 and 605) and arises with the descensus testis as a blind-sac-like prolongation of the peritonaeum, *processus vaginalis peritonaei;* it lies before the descensus as a small projection, but develops fully only with the descensus testis. This extends in the fetus in front of the ductus deferens and in front of the testicle as far as the bottom of the scrotum and surrounds a cavity which is connected at the annulus inguinalis abdominalis with the peritoneas cavity. At the time of birth or somewhat later the upper longer part of this cavity from the annulus inguinalis abdominalis as far down almost as the caput epididymidis usually becomes obliterated. (This obliteration may be delayed, may be partial, or may not occur at all.) In its place later there is found only a somewhat firm cord of connective tissue, *rudimentum processus vaginalis* (not illustrated), though this is very often absent. The lower end of this fetal peritoneal sac remains throughout life as the tunica vaginalis propria testis. This membranous sheath with its *lamina visceralis* directly covers the surface of the testicle (see p. 604) and of the epididymis (see p. 605), as well as in part the lowermost end of the ductus deferens and forms between the testicle and the epididymis the *sinus epididymidis* (see p. 605). Beyond these attachments it is continued into the *lamina parietalis,* which surrounds the testicle and epididymis with the exception of the posterior margin as a wide, loose sac and is separated from the lamina visceralis by a slit-like space containing a little serous fluid.

The **testicular sac** or *scrotum* (see Fig. 705) is a wide, loose, unpaired bag formed by the external skin; it incloses the testicles, epididymis and spermatic cords and their sheaths. Its cutis (see also Figs. 708 and 709) is connected above with that of the penis and the mons pubis, lateralward with that of the thigh, behind with that of the perineum; it is thin, of a dark color, wrinkled and possesses only a few hairs but many sebaceous and sweat glands. In the median plane runs a narrow darker strip, *raphe scroti,* from the under surface of the penis to the perineum. In the tela subcutanea of the skin lies the *tunica dartos,* a layer consisting of smooth muscle fibres interwoven in the form of a network, which is connected above with the fascia penis and fascia superficialis of the abdomen, thigh and perineum. It is continued in the median plane as the *septum scroti* (see also Fig. 709) into the interior of the scrotum, and so separates the two spaces filled up on each side by testicle, epididymis and spermatic cord; it is connected with the fascia of the penis and perineum. Beneath the tunica dartos follows a very loose subcutaneous tissue, free from fat, which forms the connection with the fascia cremasterica and the m. cremaster.

707. Ductus ejaculatorii,

viewed from in front and above.

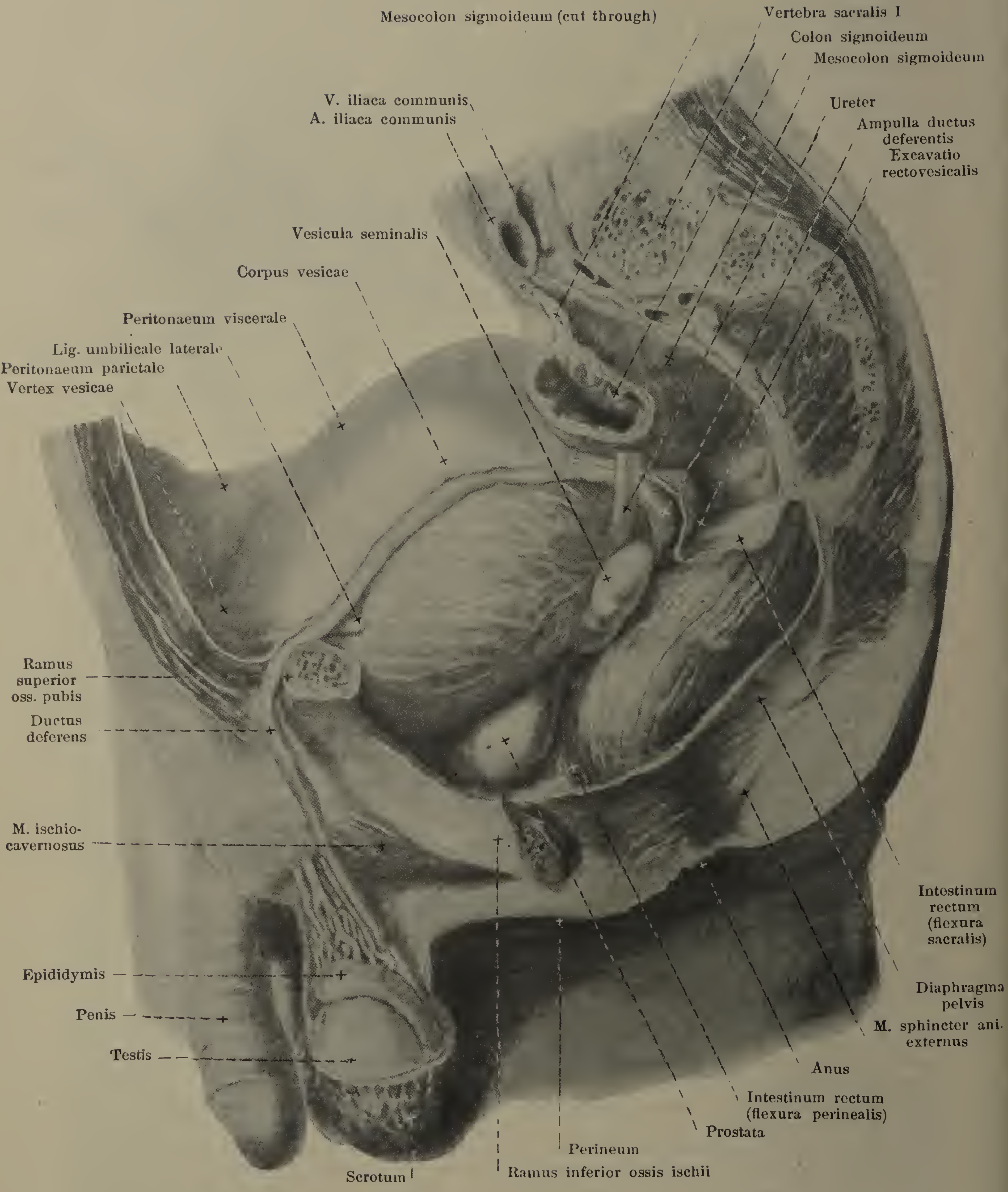
(The same preparation as in Fig. 706. In addition the right seminal vesicle has been further dissected out and a wedge has been cut out of the prostate reaching as far as the ductus ejaculatorii and the urethra.)



The **seminal vesicles,** *vesiculae seminales* (see also Figs. 650, 693, 706 and 708), are paired, oblong, flattened bodies of variable size, with a nodular surface; the upper end of each is broader, the lower end apical and directed toward the basis prostatae. Their long axes run in a plane inclined forward and downward, and at the same time they converge at their lower ends. The seminal vesicles lie above and behind the prostate; they are attached in front, when the bladder is full in their whole extent (when the bladder is empty only in their lower portions) to the posterior wall of the bladder, behind in the lower half to the rectum and are separated from the musculature of these organs by only a little loose, fatty, connective tissue. The medial margin lies on each side in contact with the ampulla ductus deferentis, and in front of its upper end runs the last portion of the ureter. The posterior surface is covered in its upper third or upper half by the peritonaeum of the excavatio rectovesicalis. Each seminal vesicle consists of a large tortuous main duct into which open a variable number of accessory ducts; the main duct is often bent like a hook. In addition all the ducts present inside depressions separated by ridges and are externally united by connective tissue to form a firm continuous mass, *corpus vesiculae seminalis.* The main duct goes over into the *ductus excretorius* at the lower end where it becomes narrower; the excretory duct unites with the lower end of the ampulla ductus deferentis to form the ductus ejaculatorius. The wall of the seminal vesicle consists of an external connective tissue layer, *tunica adventicia,* a middle, well-developed *tunica muscularis* and an internal, secreting mucous membrane, *tunica mucosa.*

The ***ductus ejaculatorius*** (see also Fig. 709) arises on each side at the basis prostatae through the union of the lower end of the ampulla ductus deferentis with the ductus excretorius of the seminal vesicle. It is a very narrow canal which runs downward and forward into the prostate, lies directly upon the wall of the utriculus prostaticus and opens at the colliculus seminalis (see also Fig. 696) by a fine, slit-like opening into the urethra.

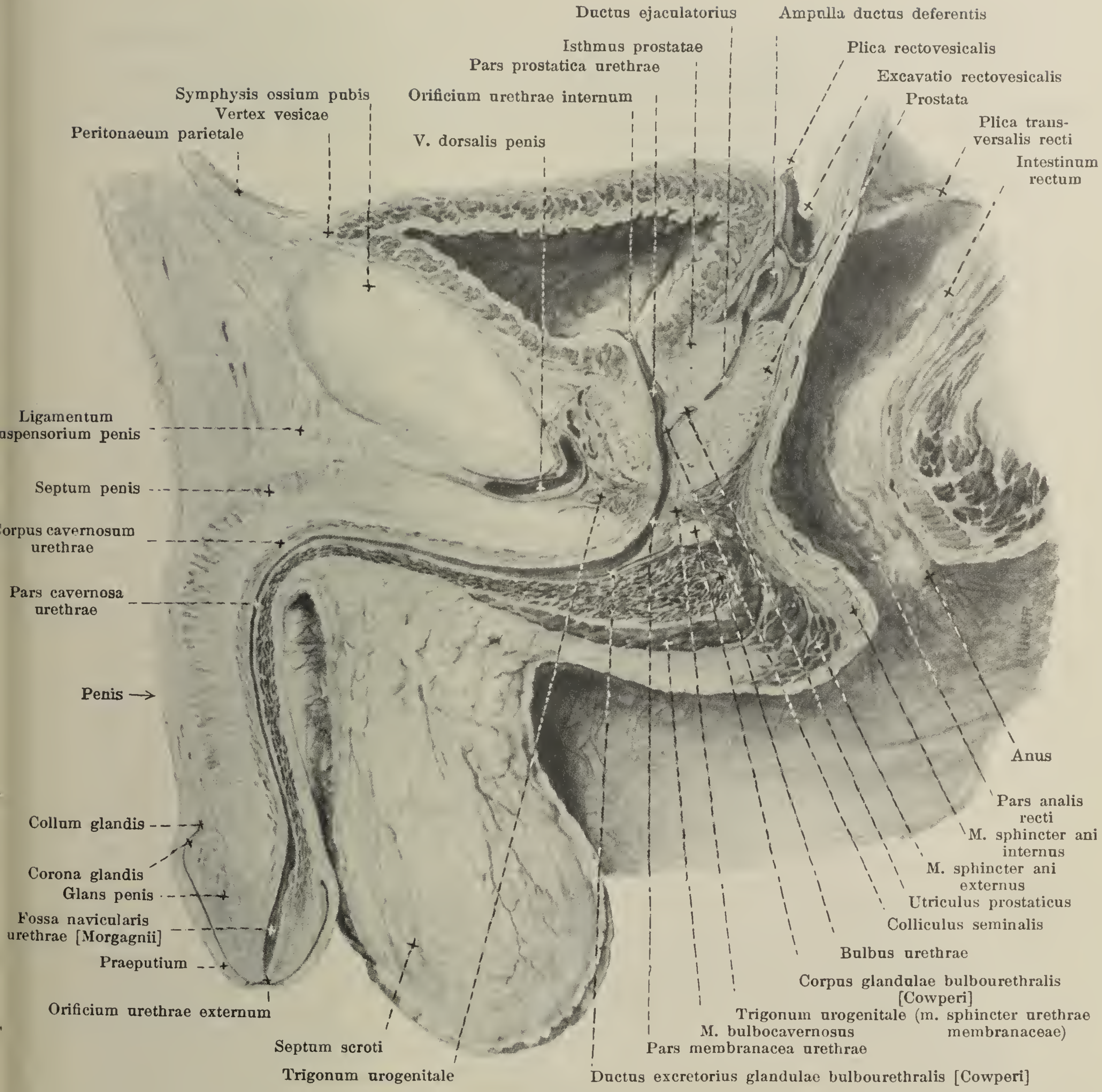
The **prostate gland,** *prostata* (see also Figs. 693, 696, 706, 708, 709 and 730), is an unpaired glandular body of the form of a chestnut, the rounded tip of which, *apex prostatae,* is directed downward and rests upon the trigonum urogenitale. Its anterior, shortest surface, *facies anterior,* which looks at the same time a little downward, lies behind the lower portion of the symphysis ossium pubis; it is separated from it by the plexus pudendalis (see also Fig. 551) and connected with it by the ligamenta puboprostatica. The lateral surfaces are bounded by the medial margins of the mm. levatores ani and the plexus vesicalis (see Figs. 551 and 730), which fills up especially the groove between the basis prostata and the bladder. The posterior surface, *facies posterior,* is in almost direct contact with the anterior wall of the rectum, being separated from it only by a little loose connective tissue, devoid of fat; it frequently presents a median, shallow groove (see Fig. 693) which only imperfectly separates the two lateral halves, *lobus dexter* and *lobus sinister,* from one another. The largest, upper surface, *basis prostatae,* is at the same time directed a little obliquely forward and is concave. That portion of it situated behind the urethra presents in the middle a deep, short transverse groove for the entrance of the ductus ejaculatorii; this groove separates a posterior from an anterior area. The posterior area lies in loose contact with the ampulla of the seminal ducts and the seminal vesicles. (Continuation see p. 611).



708. Pelvic organs in the male,

after removal of the left wall of the pelvis, viewed from the left.

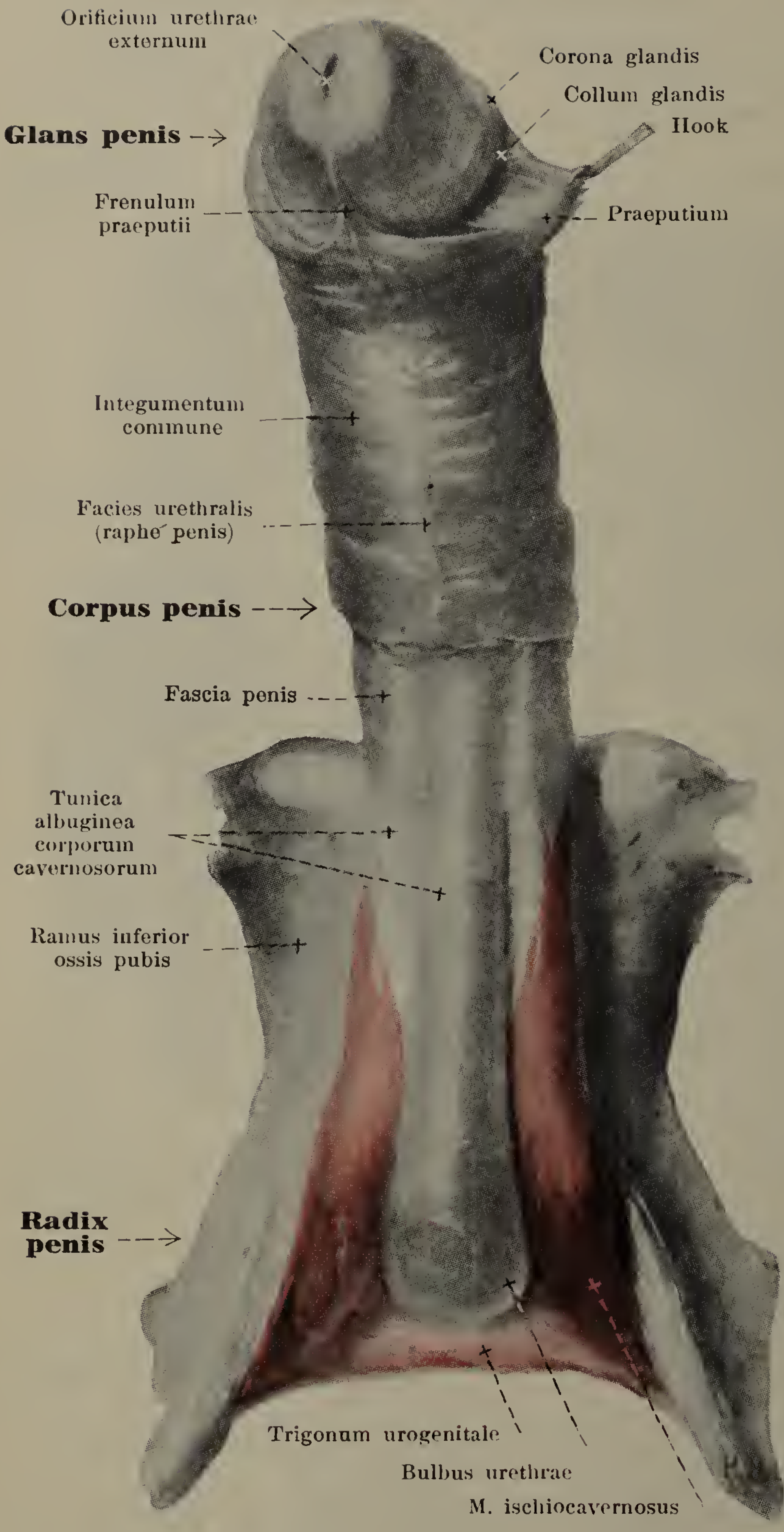
(The urinary bladder is markedly distended.)



709. **Median section through the pelvic organs in the male,** right half, viewed from the left side (partly after a frozen section by W. Braune).

(The urinary bladder has been only partly filled. The left glandula bulbourethralis [Cowperi] situated laterally from the median plane has been introduced as though projected upon the median plane. The urethra is represented as somewhat dilated.)

Prostata (continued). The area of the basis lying between the urethra and the ductus ejaculatorii, *isthmus prostatae* (see Fig. 706), is with the rest of the basis firmly united to the fundus vesicae; it may in old age project so as to form a rounded nodule, *lobus medius* (not illustrated), which bulges forward the wall of the trigonum vesicae. The prostate is obliquely perforated in its posterior upper part by the ductus ejaculatorii. Through its anterior part from the basis as far as the apex runs the pars prostatica of the urethra; it enters above at the basis and leaves the prostate a little in front and above the apex. (Continuation see p. 612.)



710. Penis, after removal of the m. bulbocavernosus, as well as of a part of the fascia and skin, viewed from below.

Prostata (continued) (see Figs. 696, 709 and 730). It consists in largest part of glandular substance which as *corpus glandulare* surrounds the first portion of the urethra in the form of a broad clasp, open in front. This clasp is closed to form a ring by the *m. prostaticus*. The latter consists, in its upper part, of smooth muscle fibres and is connected with the m. sphincter vesicae; in the lower part it is formed of striped fibres and is inseparably continuous with the m. sphincter urethrae membranaceae (see p. 629). The muscle fibres run especially transversely and radiate out into the glandular substance and upon its surface. The glandular substance consists of many (30—50) small wedge-shaped lobules, the apices of which are directed toward the urethra; each of them contains a small excretory duct, *ductus prostaticus*; of such ducts there are in all from 20 to 30, they mostly open into the urethra in the two grooves lateralward from the colliculus seminalis.

The surface of the prostate is smooth and is covered on its posterior and lateral surfaces by a sheath of connective tissue, the *fascia prostatae*.

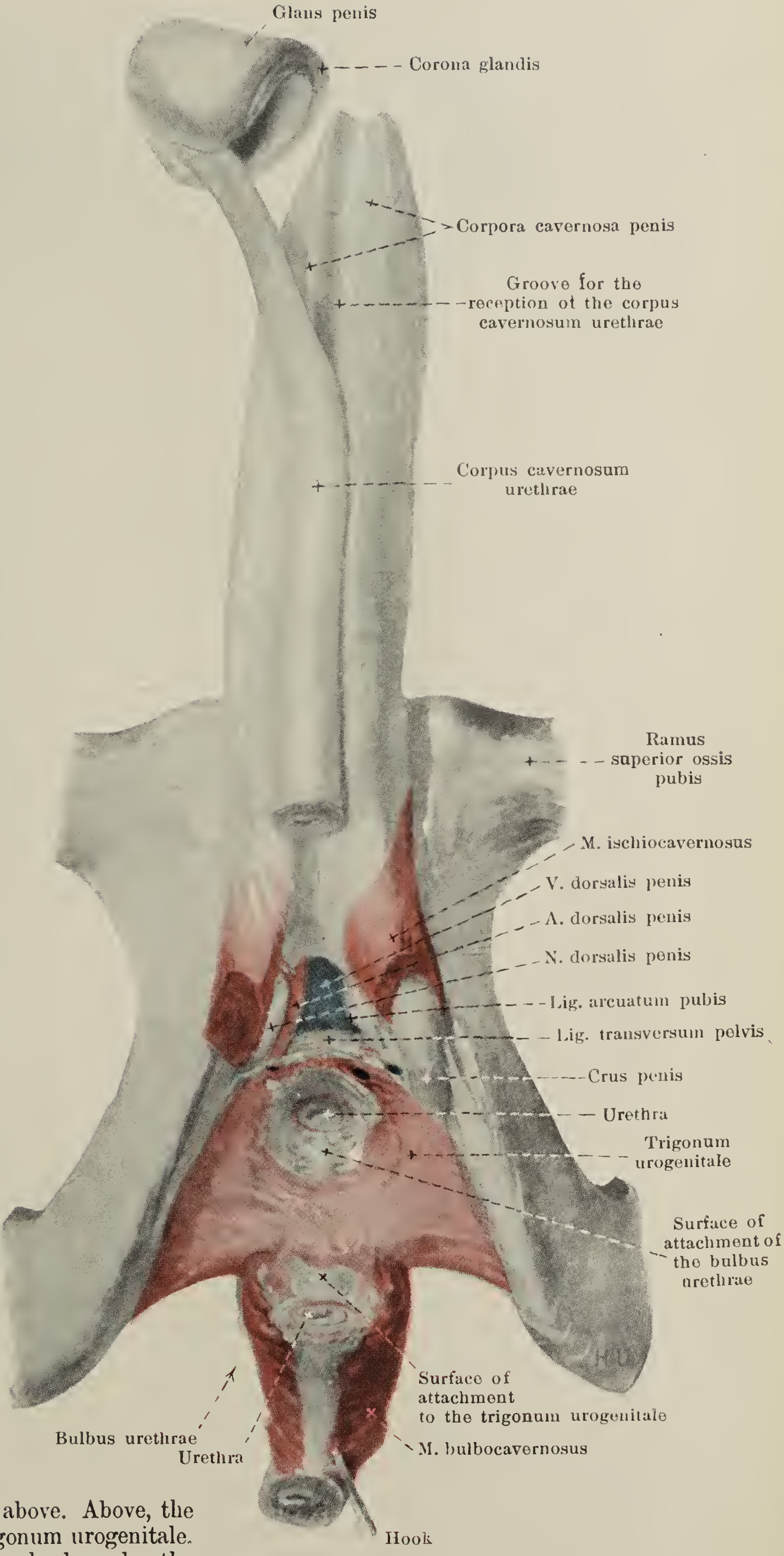
The **glandula bulbourethralis [Cowperi]** (see Figs. 693, 709 and 726) is a paired gland, of the size of a pea; the surface of this gland is nodular. It lies with its *corpus glandulae bulbourethralis* near the median plane behind the urethra, ensheathed by the fibres of the m. sphincter urethrae membranaceae, within the trigonum urogenitale. Its excretory duct, *ductus excretorius* (see Fig. 709), is very thin, runs forward in the bulbus urethrae and opens by a fine slit in the posterior part of the pars cavernosa urethrae.

The **penis** (see also Figs. 708, 709, 711—714) is a long, trilaterally-prismatic body which lies below and in front of the symphysis ossium pubis and surrounds the longest part of the urethra. It presents for examination a posterior, broader end, *radix penis*, and an anterior main portion, *corpus penis*, the free end of which is formed by the *acorn* or *glans penis*. The root and the posterior part of the corpus lie hidden below the skin of the perineum and scrotum and are immovably fastened *(pars fixa)* by fusion with the trigonum urogenitale, the pubic bones and the symphysis; the rest projects free and is easily movable *(pars mobilis)*; between these two parts when the organ is relaxed is an angle which vanishes during erection. The corpus penis possesses an upper surface, *dorsum penis*, and a lower surface, *facies urethralis*; these are not sharply separated from one another by the rounded lateral surfaces.

711. Corpora cavernosa penis and trigonum urogenitale,

viewed from below.

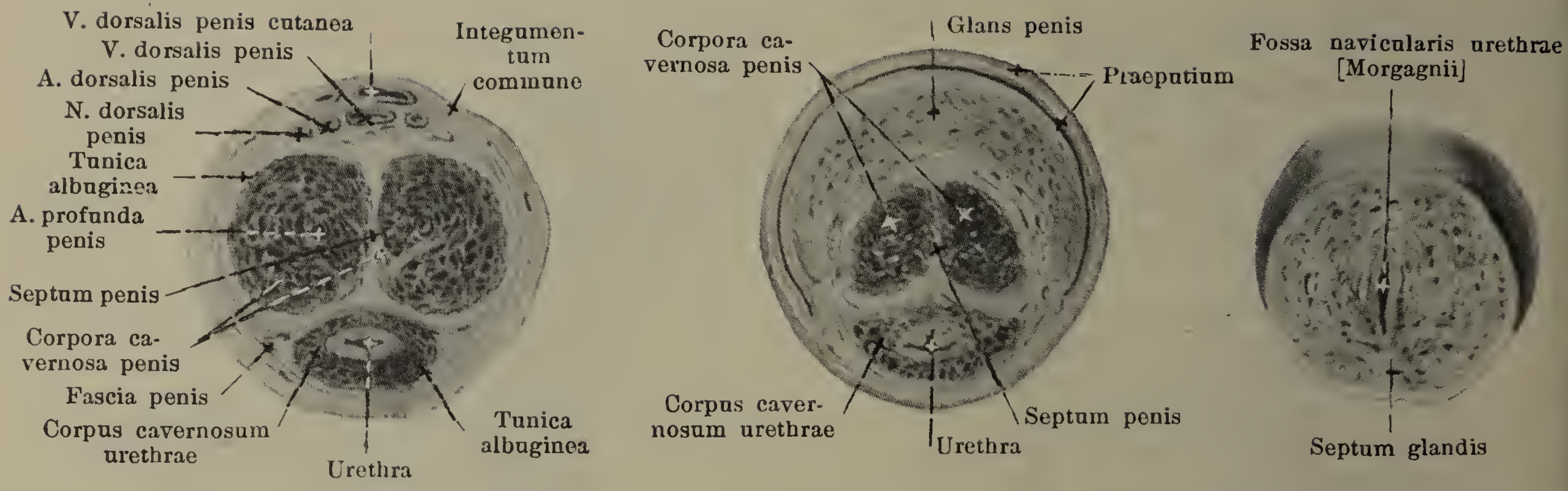
(The bulbus urethrae has been cut off distalward, dissected out and reflected backward. On the left side the m. ischiocavernosus alone has been cut through, on the right side it and also the crus penis have been cut away. The glans penis has been loosened from its position.)



Penis (continued). The penis consists chiefly of the three ***erectile bodies,*** *corpora cavernosa.*

The two *corpora cavernosa penis* are approximately cylindrical, tube-like structures. Their posterior pointed ends, *crura penis,* run converging along the medial margins of the rami inferiores of the ischium and pubis in front of the symphysis pubis and are firmly attached to the bones by fusion of their tunica albuginea with the periosteum. In front of the lower part of the symphysis the two crura unite at an acute angle to form an unpaired, flat-rounded body, which reaches by its anterior pointed end into the posterior excavation of the glans penis; its upper surface possesses a flat median groove for the v., aa. and nn. dorsales penis, its lower surface a deeper groove for the reception of the corpus cavernosum urethrae.

The *corpus cavernosum urethrae* (O. T. corpus spongiosum) is thinner and longer than the two others. It begins behind in a swelling the size of a hazelnut, the ***bulbus urethrae,*** which may be divided by a shallow constriction of the posterior margin into two ***hemisphaeria bulbi urethrae;*** this groove corresponds to a thin median ***septum bulbi urethrae*** in the interior which consists of connective tissue and projects deep down from behind and above. Above, the bulbus is firmly united with the trigonum urogenitale. The bulbus is perforated in front and above by the urethra so that its main mass lies behind the latter. In front becoming gradually narrower it goes over into the longest narrow-cylindrical part, which is attached to the corpora cavernosa penis in a longitudinal groove on their lower surface and surrounds the urethra on all sides.



712—714. Cross-sections of the penis

through the body. through the posterior part of the glans penis. through the anterior part of the glans penis.

Penis (continued). The *glands penis* or *acorn* has the form of a blunt wedge. Its excavated base is firmly united with the anterior end of the combined corpora cavernosa penis and projects lateralward and upward somewhat behind these by a swelling, the *corona glandis;* behind the corona runs a groove, *collum glandis.* The upper surface of the glans is longer and convex, the lower is more flat. The glans consists of a special erectile body which is separated from the others more or less distincly; it surrounds the anterior, reduced end of the corpus cavernosum urethrae with the urethra, which runs near its lower surface and opens at the apex of the acorn.

The *corpora cavernosa penis* are covered by a thick layer of connective tissue, *tunica albuginea corporum cavernosorum,* which extends also between the combined corpora cavernosa as the *septum penis;* in front and dorsalward the latter possesses numerous slit-like openings through which the vessels of the two corpora cavernosa communicate with one another (see Fig. 709). Numerous leaf-like or thread-like columns, *trabeculae corporum cavernosorum,* containing smooth muscle fibres, go off from the tunica albuginea into the interior, where they form a close network; the meshes of the same are smaller in the periphery than near the septum and surround spaces filled with blood, *cavernae corporum cavernosorum.* Through this network of trabeculae extending forward on each side near the septum is the a. profunda penis. The arterial branches run in the trabeculae and open directly into the cavities by means of precapillary branches. Part of them, especially these in the crura penis, appear to be bent around tendril-like at the end, *arteriae helicinae,* when the organ is relaxed. The veins, *venae cavernosae,* from the posterior, larger part of the corpora from the vv. profundae penis; in front and in the middle they pierce the tunica albuginea at various places, surrounding arch-like the penis (see Fig. 551) and reach the v. dorsalis penis.

The *corpus cavernosum urethrae* is covered by a. thin tunica albuginea; with the exception of the bulbus, in it no arteries open directly into venous spaces; it is composed solely of especially well developed submucous venous plexuses; their channels of exit empty partly into the branches of the v. dorsalis penis which surround the penis, partly directly into the vv. pudendae internae. The larger part of the corpus cavernosum lies under the urethra.

The *glans penis* is covered by a thin tunica albuginea, which sends a median *septum glandis,* composed of connective tissue from the lower surface as far as the urethra. The erectile tissue of the glans has essentially the same construction as that of the urethra.

The penis is attached above by means of two ligaments. The short, triangular, tough *ligamentum suspensorium penis* (see Figs. 705 and 709) goes from the anterior surface of the symphysis ossium pubis on the pars fixa penis to the tunica albuginea of the combined corpora cavernosa penis. The *ligamentum fundiforme penis* (see p. 297) surrounds the penis at the borderline between pars mobilis and pars fixa.

Loose connective tissue, the *fascia penis* (see also Fig. 710), covers the organ, and also the v., aa. and nn. dorsales penis, from the radix as far as the collum glandis; it is connected with the tunica dartos as well as with the fasciae superficiales perinei and abdominis.

The *skin, integumentum commune,* of the penis (see also Fig. 710) covers only the pars mobilis, is delicate, almost devoid of hairs, extensible and united by loose subcutaneous tissue, free from fat, with the fascia penis so as to be easily movable. On its lower surface a narrow dark strip, *raphe penis,* runs forward as a continuation of the raphe scroti as far as the prepuce. From the collum glandis on, the skin forms a folded duplicature, the *prepuce, praeputium* (see also Figs. 709 and 710), in that it goes forward at first over the apex of the glans, is then reflected, runs backward again as far as the collum glandis and finally, becoming very thinned, covers the surface of the glans directly; it is connected with the lower surface of the glans by a median fold, *frenulum praeputii.*

The **male urethra**, *urethra virilis* (see Fig. 709), is the excretory duct of the bladder and (with the exception of its initial portion) also of the genital organs; it begins at the collum vesicae at the *orificium urethrae internum*, and ends at the apex of the glans penis at the *orificium urethrae externum*. When the penis is relaxed the urethra describes in its course an ∾-shaped curve which varies individually, and is divided according to the structures perforated by it into a *pars prostatica*, *pars membranacea* and *pars cavernosa*.

The *pars prostatica* (prostatic portion of the urethra) (see Figs. 696 and 709) perforates the prostate from the base to the apex, surrounded by it on all sides and runs in an almost vertical direction. At the orificium urethrae internum and directly beneath it, it is surrounded by the *annulus urethralis vesicae* (see p. 602). In the middle of its posterior wall projects an oblong, rounded elevation, *colliculus seminalis;* this appears as aswelling on a longitudinal ridge of mucous membrane, *crista urethralis*, which reaches from the uvula vesicae on into the pars membranacea and even somewhat farther and distalward frequently bifurcates. Above the colliculus and in front of it the urethra is markedly bulged out being deepened at its two sides to form grooves. The colliculus contains the openings of the ductus ejaculatorii, of several ductus prostatici and in the median plane an oblong, slit-like blind sac, the *utriculus prostaticus (vagina masculina)*. which is directed obliquely upward toward the basis prostatae and opens, slit-like, at the level of the colliculus. The utriculus is the rudiment of the fused caudal extremities of Müller's ducts.

The *pars membranacea* (see Figs. 709 and 726) perforates the trigonum urogenitale obliquely from behind and above forward and downward and is almost immovably attached in it. It is surrounded by a ring of cavernous tissue and by a layer of cross-striped muscle fibres, *m. sphincter urethrae membranaceae* (see p. 629), which goes over proximalward directly into the m. prostaticus and can be followed distalward as far as the anterior half of the penis.

The *pars cavernosa* (cavernous portion of the urethra) (see Figs. 709, 712—714) runs within the corpus cavernosum urethrae and the glans penis. Behind, it is curved so as to be slightly convex downward, then extends forward and somewhat upward and finally if the penis is flaccid bends downward. In the region of the bulbus it is regularly bulged out somewhat backward. In this region open also the glandulae bulbourethrales [Cowperi]. In the glans penis it presents an oblong dilatation, *fossa navicularis urethrae [Morgagnii];* on its upper wall there is frequently a thin fold of mucous membrane, *valvula fossae navicularis* (not illustrated), which bounds a pocket, open in front.

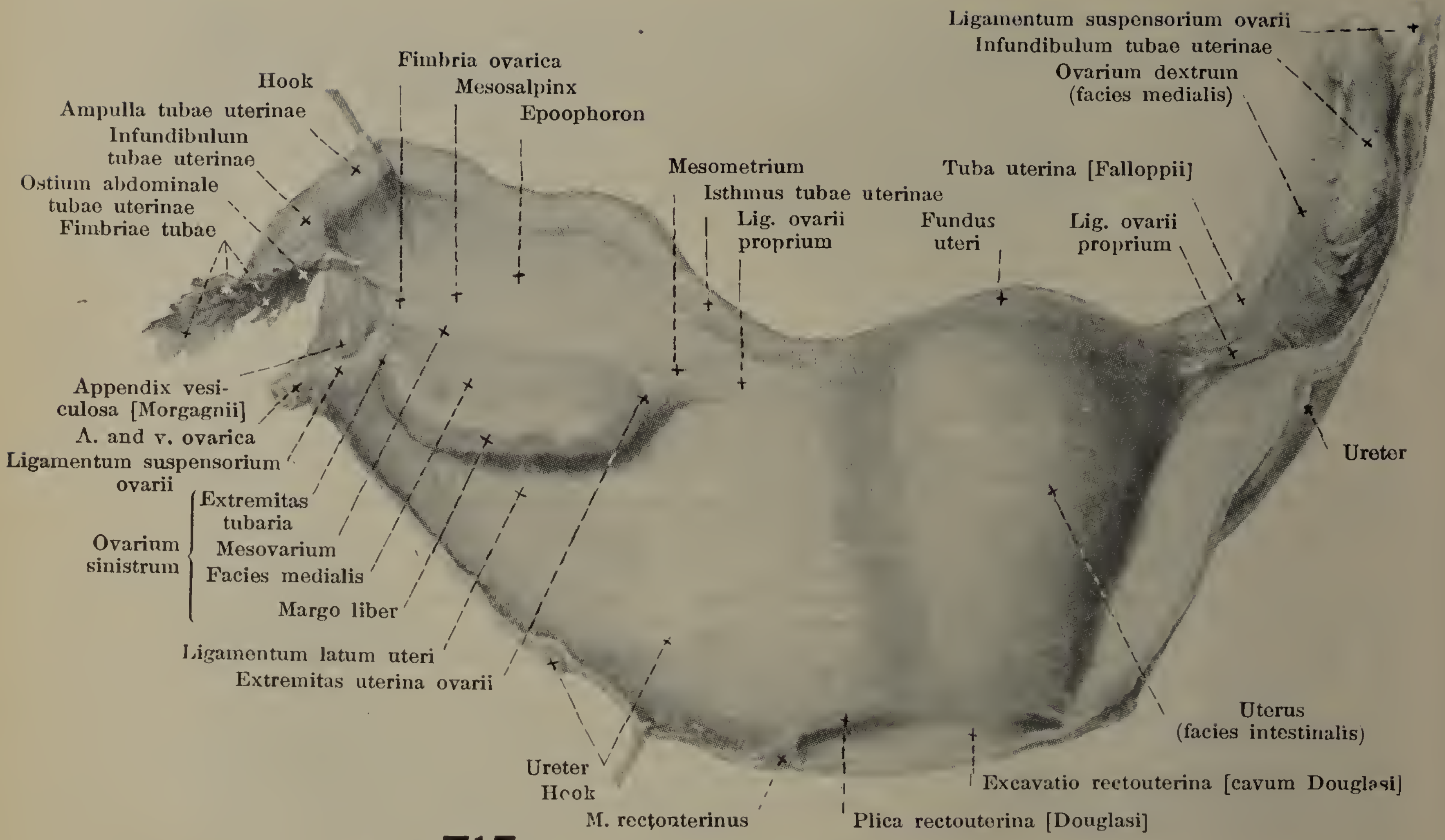
The walls of the empty urethra lie directly in contact with one another. At the orificium urethrae internum, in the pars prostatica and pars membranacea (see Fig. 711) its *lumen* forms a slit which is convex forward, the greatest breadth and depth of which corresponds to the colliculus seminalis; in the most posterior part of the pars cavernosa it is a vertical slit, in the larger anterior portion (see Fig. 712) it is a slit which is slightly concave dorsalward; in the base of the glans it is ⊥-shaped (see Fig. 713), in the fossa navicularis and at the orificium externum it is a vertical slit (see Fig. 714).

The *caliber* of the urethra is narrowest at the orificium externum and becomes dilated in the fossa navicularis; then follows the progressively somewhat narrower, long stretch of the pars cavernosa as far as the second dilatation in the bulbus urethrae; upon this again follows a marked narrowing in the pars membranacea, then a third wider portion in the pars prostatica, and finally again a narrowing at the annulus urethralis. The two narrowest spots (at the orificium externum and in the pars membranacea) are also the least extensible.

The urethra is lined by a thin, whitish mucous membrane. This possesses, except in the most anterior portion, small glands, *glandulae urethrales [Littrei];* they open partly into the *lacunae urethrales [Morgagnii]* (see Fig. 695), which are small pockets of mucous membrane, open forward occurring especially in the upper wall of the pars cavernosa.

Course of the peritonaeum in the male pelvis (see Figs. 649, 650, 708 and 709).

From the posterior surface of the anterior abdominal wall the peritonaeum goes directly over upon the upper surface of the urinary bladder; on the side it covers for a certain distance the lateral surfaces of the small pelvis, that is, the vessels and nerves situated there, the ureters and the seminal ducts, before it is reflected upon the wall of the bladder. This distance is larger when the bladder is empty than when it is full. In addition when the bladder is empty the peritonaeum forms a larger fold, *plica vesicalis transversa* (see also Figs. 719 and 720), which runs transversely over the upper surface of the bladder toward the origin of the annulus inguinalis abdominalis; less constantly present are from two to three smaller folds, *plicae pubovesicales* (see Fig. 650), which extend from the region of the vertex vesicae toward the plica umbilicalis lateralis. Behind the peritonaeum covers a portion of the fundus vesicae, the seminal vesicles and the seminal ducts and then bends around into the tunica serosa of the rectum. Between the bladder and rectum there thus arises a pocket, generally slit-like, *excavatio rectovesicalis*. It is deepest in the middle but as a rule does not reach down to the prostate and is bounded above by two folds, *plicae rectovesicales*, which go from the posterior part of the bladder in the form of an arch to the lateral surface of the rectum; the folds contain smooth muscle fibres in their bases, *mm. rectovesicales*.



715.

Uterus, Falloppian tubes and ovaries, viewed from behind.

(On the right the parts have been left in their natural position, on the left the ligamentum latum has been unfolded.)

The **ovaries,** *ovaria* (see also Figs. 716—720), are the two genital glands in the female; they lie in the small pelvis and are attached by a narrow fold of peritonaeum, *mesovarium,* to the posterior surface of the ligamentum latum uteri.

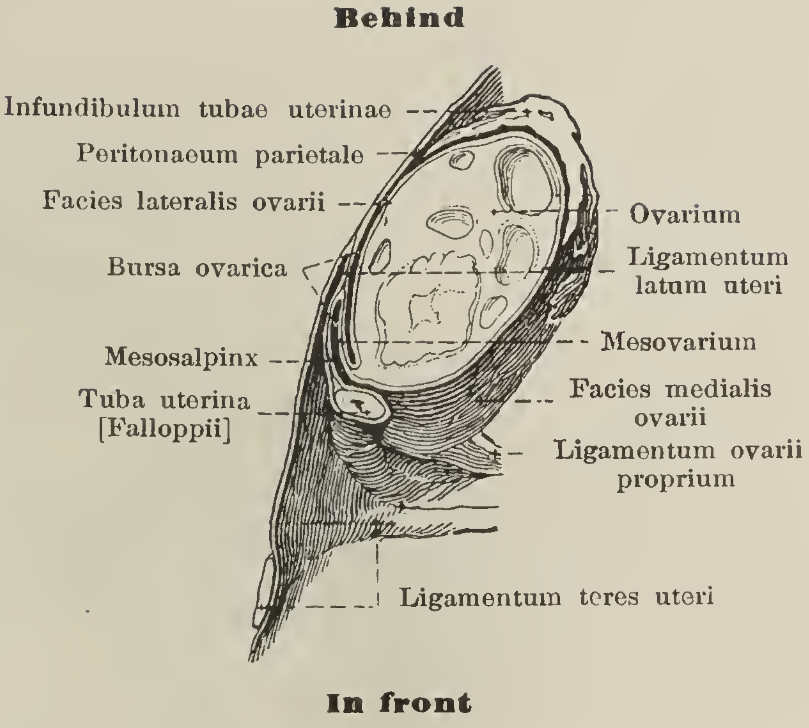
Each ovary has the form of a flattened ellipsoid. It presents for examination a *facies medialis* and a *facies lateralis,* a *pole* directed upward, *extremitas tubaria,* and a somewhat narrower pole looking downward, *extremitas uterina;* its more convex, posterior margin, *margo liber,* is free; its more straight, anterior margin, *margo mesovaricus,* is attached to the mesovarium. The latter margin presents also an oblong groove, *hilus ovarii,* for the entrance and exit of vessels and nerves. From the lower pole goes off the ligamentum ovarii proprium and to the upper pole the fimbria ovarica is attached.

The ovary (see also Figs. 717—720) is placed almost exactly sagittally in its largest plane of hemisection, and nearly vertically in its longest diameter (when the body is in upright position); it is freely movable and can be easily displaced from its position. Its lateral surface lies directly in contact with the peritoneal covering of the lateral wall of the small pelvis. The area of apposition is sometimes depressed so as to form a hollow, lies below and behind the a. and v. iliaca externa and is bounded in front and above by the a. umbilicalis, behind and above by the a. and v. hypogastrica and by the ureter, which in this situation runs on the anterior margin of the a. hypogastrica and before it; lateralward from this area are situated the n. obturatorius, the a. and v. obturatoria and the m. obturator internus. It is rare that the two ovaries lie exactly symmetrically. If the uterus is displaced to the right, then the left ovary sinks somewhat and its lower pole is turned somewhat medianward and vice versa. The ovarium is partly overlain by the tuba uterina, so that only a small part of its medial surface looks free into the pelvic cavity.

The surface of the ovary covered by the germinal epithelium is grayish-red; in childhood it is smooth, later it is uneven on account of nodular projections and scarred depressions. The interior (see Fig. 717) consists of a central medullary layer and a peripheral cortical layer. The latter contains spherical structures, up to the size of a pea, the *egg follicles,* the largest of which project beyond the surface. The smaller are called *primary follicles, folliculi oophori primarii,* the larger contain a clear fluid, *liquor folliculi,* and are called *Graafian follicles, folliculi oophori vesiculosi [Graafi].* Each egg follicle contains one egg, *ovulum;* the follicles are separated from one another by firm connective tissue, *stroma ovarii.* After the extrusion of the egg from the follicle a *corpus luteum* develops from the latter; this changes later into a firm mass of connective tissue, *corpus albicans,* and finally vanishes entirely.

716. Right ovary and Falloppian tube

in their natural position,
cut through transversely



The **uterine** or **Falloppian tube,** *tuba uterina [Falloppii]* (see also Figs. 715, 717—720), is a paired, long, thin, tube-like structure, which runs from the ovary to the uterus and is movably attached to the ligamentum latum uteri by means of a thin fold of peritonaeum, the *mesosalpinx.*

The tuba uterina (see Figs. 715 and 717) begins at the ovary by a wide, funnel-shaped portion, *infundibulum tubae uterinae,* the margin of which is split up into numerous narrow, very jagged processes, *fimbriae tubae;* one of these, the *fimbria ovarica,* is as a rule longer than the others, is continued along the free edge of the mesosalpinx as far as the extremitas tubaria of the ovary and forms a groove beside the ovary. The inner surface of the fimbriae is studded with numerous folds of mucous membrane, which are continued directly into the longitudinal folds of the ampulla; between them, in the depth, is situated the narrow opening, *ostium abdominale tubae uterinae.* The longer portion following upon the infundibulum is called the *ampulla tubae uterinae;* it is tortuous and narrows gradually toward the narrowest part, the *isthmus tubae uterinae,* which is immediately adjacent to the uterus. The short terminal portion of the Faloppian tube, *pars uterina,* lies within the wall of the uterus and opens into the cavum uteri by a narrow funnel-shaped opening, *ostium uterinum tubae.*

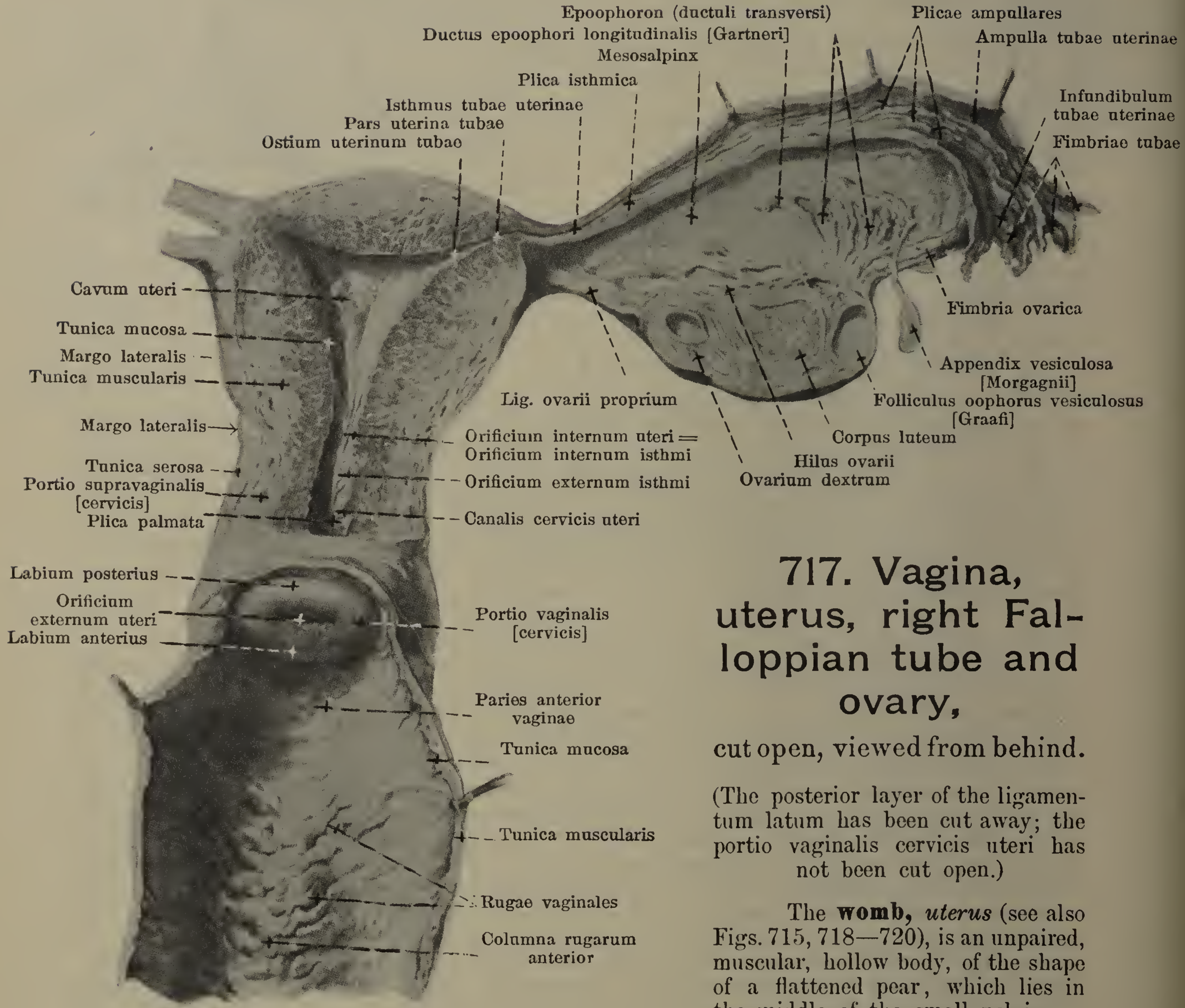
The isthmus runs (see also Figs. 715, 717—720), when the body is upright, nearly horizontally in a frontal plane as far as the extremitas uterina of the ovary. The Falloppian tube there bends around almost at a right angle and, lying close to the wall of the pelvis, ascends straight or tortous in front of the margo mesovaricus or at the medial surface of the ovary as far as the extremitas tubaria. Here it turns again abruptly downward and somewhat backward and along with the inner surface of the infundibulum lies directly upon the margo liber and the posterior portion of the facies medialis; the fimbria ovarica thus ascends in a recurrent direction to the extremitas tubaria. Since the ovary lies against the peritonaeum parietale of the pelvic wall lateralward and since in front, above, behind and partly also medianward it is overlapped directly by the Falloppian tube and by the mesosalpinx, it is enclosed by these parts in a pocket, *bursa ovarica,* the slit-like lumen of which is connected with the cavum peritonaei only laterally behind and medianly in front.

The Falloppian tube is covered on its external surface by peritonaeum, *tunica serosa,* beneath which lies a loose connective tissue, *tunica adventicia.* Then follows a layer of smooth muscle fibres, *tunica muscularis,* in which can be distinguished a thinner external longitudinal layer, *stratum longitudinale,* and a thicker internal circular layer, *stratum circulare.* The inner surface is formed by a grayish-red mucous membrane, *tunica mucosa.* This everywhere presents very delicate folds, *plicae tubariae* (see Fig. 717), which begin in the pars uterina as simple, low, longitudinal folds and become larger in the isthmus, *plicae isthmicae;* in the ampulla they are highest and form the *plicae ampullares,* and here they are studded with accessory folds. At the free jagged margin of the infundibulum the mucous membrane is continued directly into the peritonaeum.

The *epoophoron* (see Figs. 715 and 717) is a small flattened body which lies on each side in the lateral portion of the mesosalpinx between its peritoneal layers. It consists of several short canals, *ductuli transversi,* which converge toward the hilus ovarii and near the the Falloppian tube open almost at a right angle into a main canal, *ductus epoophori longitudinalis [Gartneri].* The latter represents the remains of the embryonal Wolffian duct, the ductuli transversi being remains of the tubules of the Wolffian body.

Appendices vesiculosae [Morgagnii] (see Figs. 715 and 717). O. T. hydatids of Morgagni.) Hanging down free, almost constantly, from the region of the epoophoron, one or several pedunculated vesicles filled with fluid; they have their origin in the Wolffian duct.

Paroophoron (not illustrated) seen with the naked eye only until the first year, is a flat, roundish, brown or grayish-yellow body, which lies medially from the epoophoron, between the leaves of the mesosalpinx in the vicinity of the angle between the uterus and tube. It contains canaliculi and glomeruli, as the remains of the caudal part of the Wolffian body.



717. Vagina, uterus, right Falloppian tube and ovary,

cut open, viewed from behind.

(The posterior layer of the ligamentum latum has been cut away; the portio vaginalis cervicis uteri has not been cut open.)

The **womb,** *uterus* (see also Figs. 715, 718—720), is an unpaired, muscular, hollow body, of the shape of a flattened pear, which lies in the middle of the small pelvis.

It presents for examination a larger and thicker *body, corpus uteri*, and a *neck, cervix [uteri].* The body possesses an inferior, fairly smooth surface lying upon the urinary bladder, *facies vesicalis,* and an upper surface, turned at the same time somewhat backward, *facies intestinalis,* which is curved above so as to be convex in the frontal and sagittal directions. The anterior, blind end is broad and convex (more markedly convex in women who have borne children than in nulliparae); that portion of it which projects beyond the line between the openings of the Falloppian tubes is called the *fundus uteri.* The body narrows behind, goes over into the cervix and is usually marked off from the latter by a shallow constriction. Lateralward on each side runs a blunt margin, *margo lateralis,* from which the ligamentum latum uteri goes off. The neck in children and nulliparae is spindle-shaped; in women who have borne children it is of a cylindrical shape. Its posterior, inferior third is surrounded by the upper end of the vagina and projects into the cavity of the latter; it is called the *portio vaginalis [cervicis]*; the remaining part of the cervix is the *portio supravaginalis [cervicis].* The portio vaginalis is transversely elliptical and divided by the round or transversely oval *orificium uteri externum, external mouth of the womb,* into a *labium posterius,* and a *labium anterius,* both of which are smooth and of almost equal thickness; the anterior lip extends deeper down but is shorter than the posterior; in women who have borne children, the orificium is a transverse slit with irregular margins.

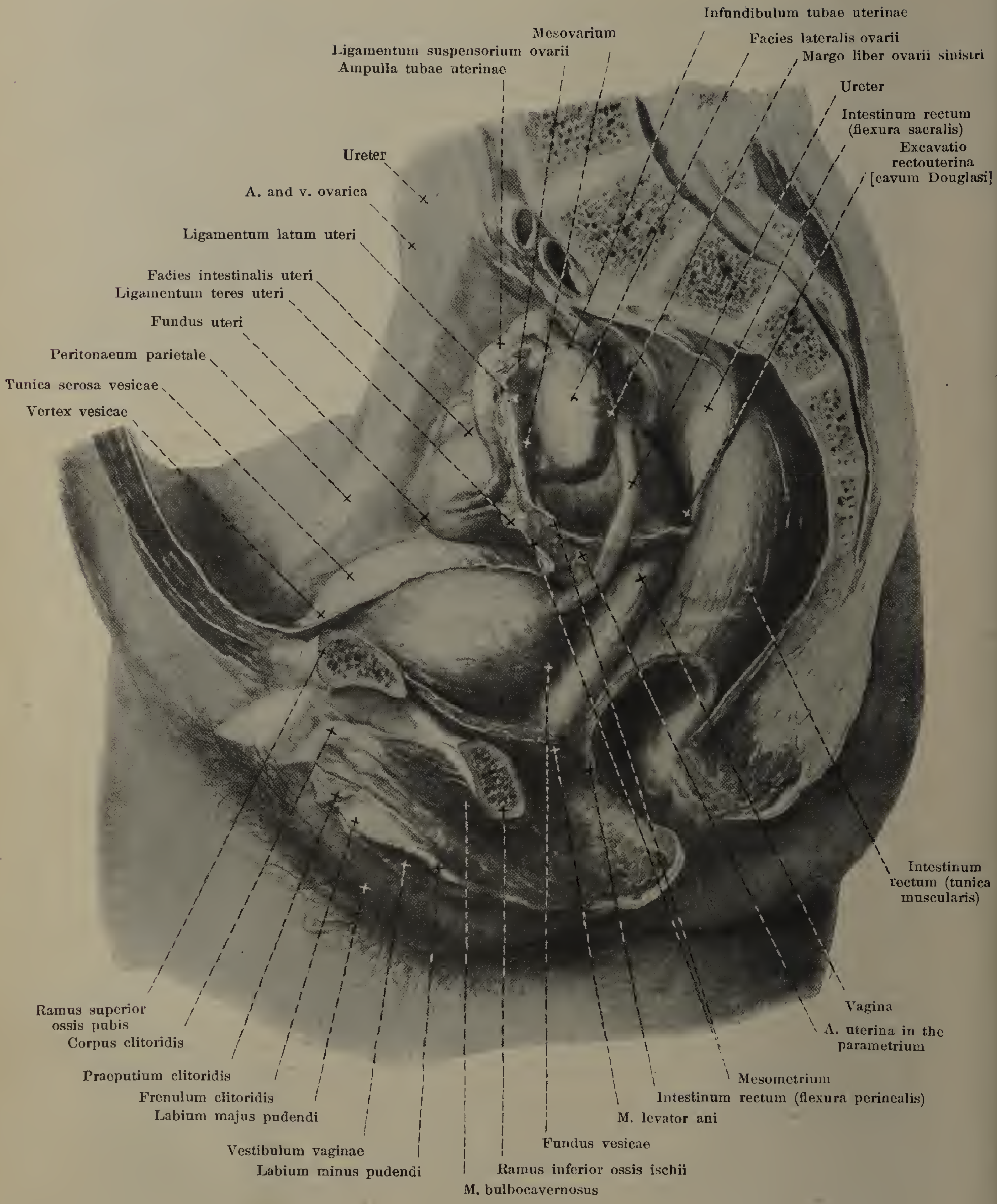
Uterus (continued).

The uterus belongs to the most movable parts of the body. Not only is the organ as a whole movable but the body is movable on the neck, which is relatively firmly attached to the vagina, urinary bladder and vessels. Its position can vary within broad limits, but the typical situation is as follows (see Figs. 718—720). When the body is in the upright position, and the bladder and rectum empty, the orificium externum uteri usually lies at the level of the upper margin of the symphysis ossium pubis and in a frontal plane passing through the spinae ischiadicae; above, the uterus does not reach the plane of the pelvic inlet. The long axis drawn from the fundus to the external orifice of the uterus lies above in front of the axis pelvis (see Fig. 206) *(anteversion* of the whole uterus). The long axis of the cervix runs almost in the axis pelvis, that of the corpus almost horizontally; the two form an angle which varies from 70° to 100° *(anteflexion* of the body of the uterus). The uterus lies usually somewhat asymmetrically; its anterior end especially tends to be displaced somewhat toward the right; it may even be turned toward the left. When the bladder fills, the anteflexion is diminished (its angle becomes larger) and the whole organ is displaced backward and upward. When the rectum fills, the anteflexion becomes larger (its angle is diminished in size) and the whole organ is displaced forward. The facies vesicalis of the corpus uteri lies upon the upper surface of the urinary bladder and causes a saucer-like depression in the latter when empty. The anterior wall of the cervix is connected by loose tissue with the posterior wall of the bladder. Close to the facies intestinalis of the corpus uteri lie loops of the intestine and the posterior surface of the neck helps to form the excavatio rectouterina. The lateral surfaces of the corpus and of the cervix adjoin the parametrium (see p. 623).

The uterus possesses in part a (visceral) peritoneal coat, *tunica serosa (perimetrium)* (see Figs. 717—719). This covers the posterior surface of the portio supravaginalis cervicis as well as the facies intestinalis, the fundus and the facies vesicalis of the body and is reflected in front at the junction between the corpus and cervix, at the level of the orificium internum uteri, upon the urinary bladder. It is attached very firmly to the fundus and the largest part of the body, lateralward more loosely, to the cervix very loosely and at the margo lateralis goes over directly into the ligamentum latum uteri. Beneath the tunica serosa is situated the thick *tunica muscularis (myometrium),* composed of smooth muscle fibres, and consisting at the body mainly of a middle circular layer. The corresponding layer of the cervix, *tunica muscularis cervicis,* is formed by a thick middle layer of circular fibres as well as of an external and an internal thin layer of longitudinal fibres. The musculature is connected with that of the vagina, of the Falloppian tubes, of the ligamenta teretia and ovärii propria and with the mm. rectouterini. The inner covering is formed by the mucous membrane, *tunica mucosa.* This is of a grayish-red color, is firmly connected with the musculature and contains in the corpus tube-like glands, *glandulae uterinae,* in the cervix markedly dilated, *glandulae cervicales [uteri],* which secrete mucus. The mucous membrane in the body is smooth and surrounds a cavity (see Figs. 717 and 719). In the corpus this is a triangular slit, *cavum uteri,* the anterior and posterior wall of which usually lie close against one another; the sides project so as to be convex inward in women who have not borne children; the upper two corners go over like funnels into the ostia uterina of the Fallopian tubes, the lower end is separated only imperfectly from the canalis cervicis uteri by a canal-like narrowing, *orificium internum uteri.* The cavity situated in the neck, *canalis cervicis uteri,* has a rounded spindle-shaped, slit-like lumen, is widest in the middle and opens into the vagina through the *orificium externum uteri* (see p. 618). Its mucous membrane presents a fold-formation, *plica palmata,* on its anterior and posterior walls; this consists of a thicker median ridge and finer folds going off obliquely from it lateralward and to the Falloppian tubes; the formation gradually vanishes at the orificium internum uteri.

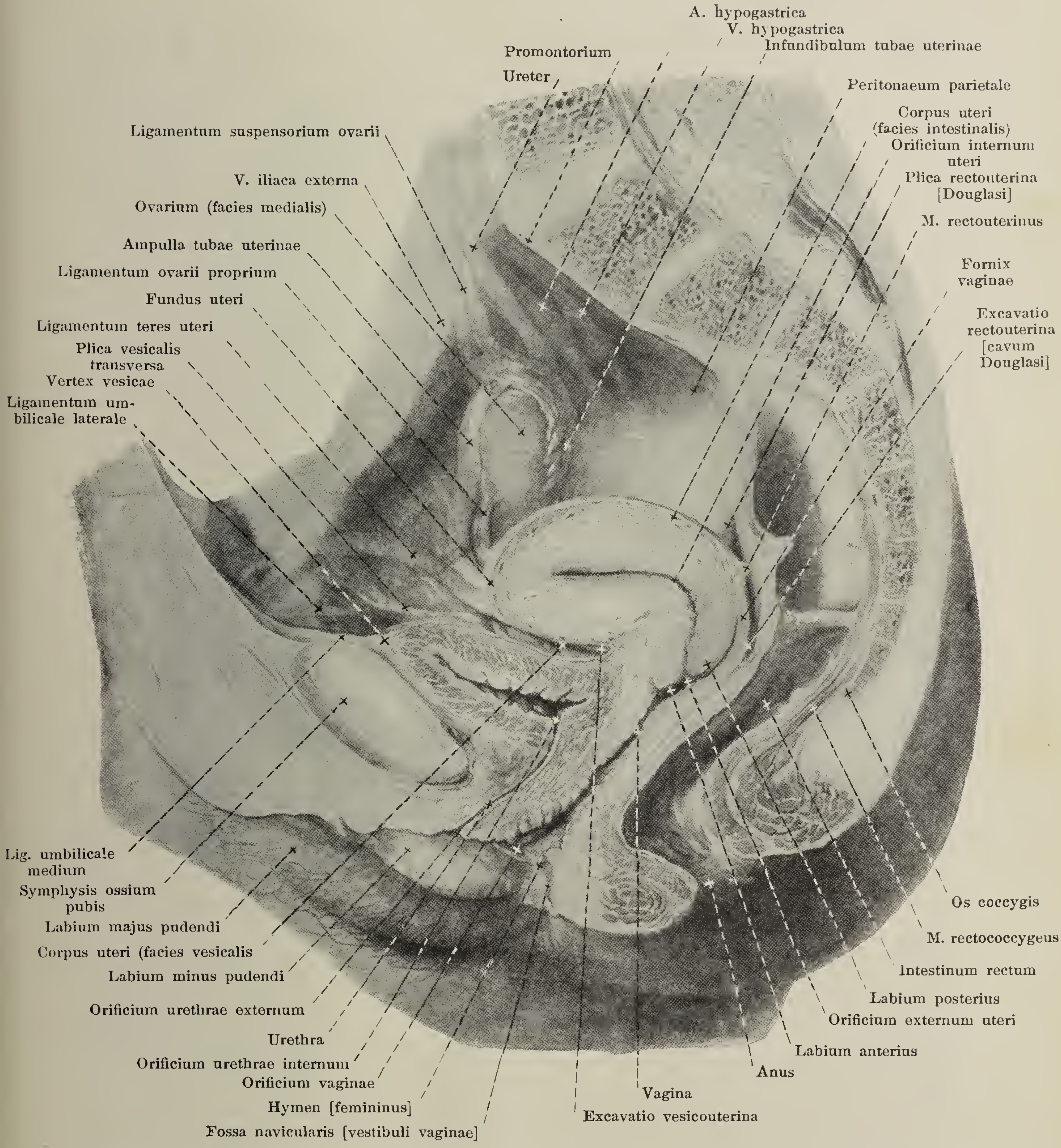
Ligamentum teres uteri (round ligament of the uterus) (see Figs. 718—720 and 728) is a rounded, smooth cord about the size of a goose quill consisting of connective tissue and smooth muscle fibres; it arises on each side from the margo lateralis uteri in front of and below the Fallopian tube, runs at first horizontally in the ligamentum latum uteri in front of the isthmus tubae uterinae to the lateral wall of the small pelvis and then passes upward on this and forward to the annulus inguinalis abdominalis. In this last portion of its course it runs almost exactly as does the ductus deferens in the male (see p. 606). Finally it enters the inguinal canal, extends with the a. and vv. ligamenti teretis uteri, n. spermaticus externus and n. iloinguinalis as well as with some cross-striped muscle fibres (m. cremaster) as far as the annulus inguinalis subcutaneus and, spreading out, goes partly to the periphery of the latter, partly to the connective tissue and skin of the labium majus. At the annulus inguinalis abdominalis, lying in front and over it, is a small sac-like prolongation of the peritonaeum, *processus vaginalis peritonaei* (not illustrated), which is longer in fetal life and sometimes persists so.

Ligamentum ovarii proprium (O. T. ligament of the ovary) (see Figs. 715, 717, 719 and 720) consists of connective tissue and smooth muscle fibres; it goes off on each side as a rounded cord from the upper end of the margo lateralis uteri, extends in the ligamentum latum to the extremitas uterina of the ovary and becomes lost in the hilus of the latter.



718. Pelvic organs in the female, after removal of the left pelvic wall, viewed from the left.

(The urinary bladder is only partially filled. A piece has been cut out of the rectum.)

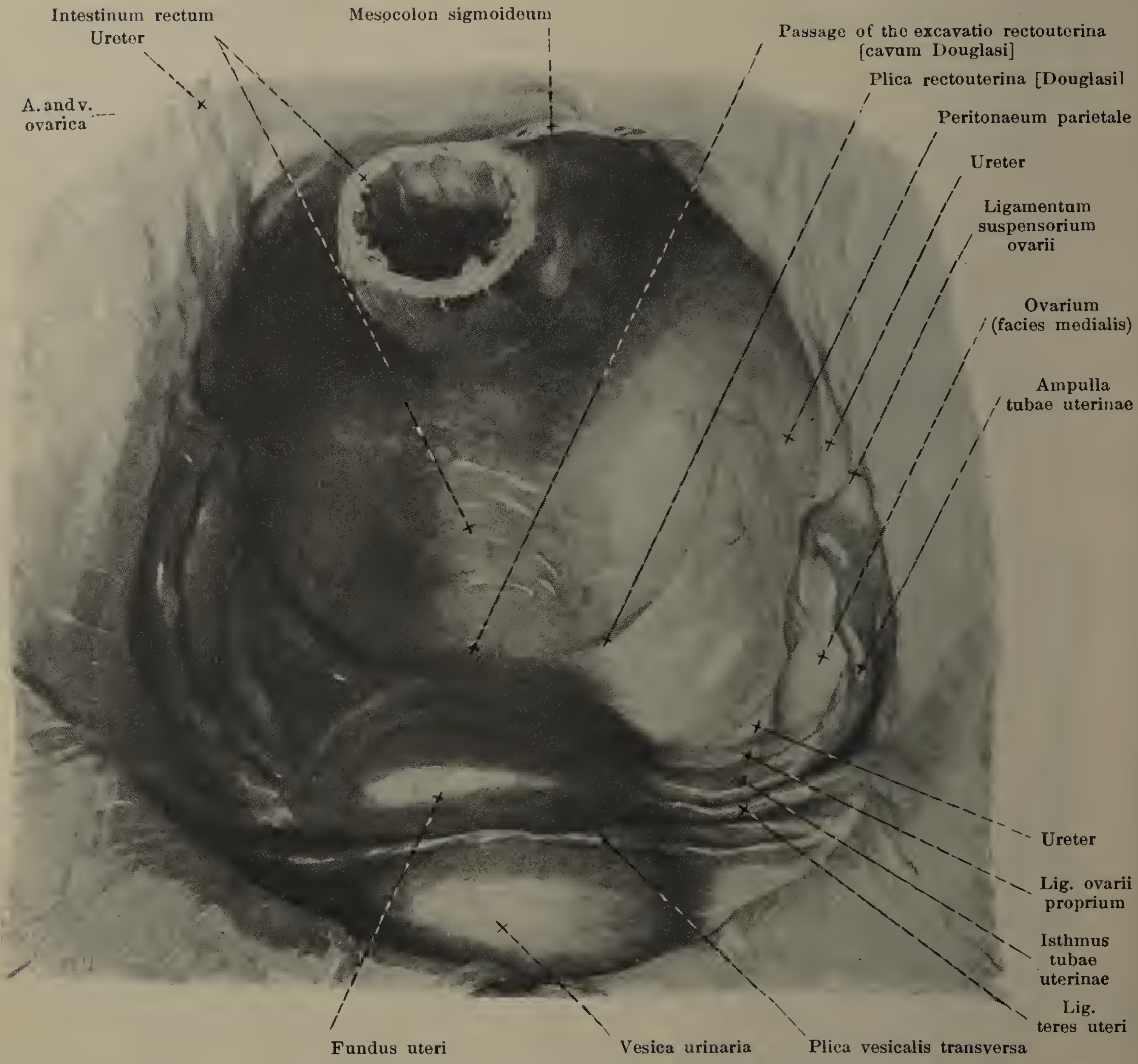


719. **Median section through the pelvic organs in the female,**

right half, viewed from the left (partly after a frozen section by W. Braune).

(The urinary bladder is empty. The canals lined by mucous membrane and the peritoneal spaces are represented as though somewhat dilated.)

M. rectouterinus (see also Fig. 715) is the name given to the smooth muscle fibres which run in the plica rectouterina [Douglasi] on each side. It arises as a flat, rounded cord from the posterior wall of the neck of the uterus, radiates out near the rectum into the neighborhood of the latter and extends in part to the musculature of the rectum, in part to the anterior surface of the sacrum.



720. Pelvic organs in the female, viewed from above.

The **vagina** (see Figs. 717—719) is a flattened muscular tube. It ends blind behind and above by an extremity which surrounds the portio vaginalis [cervicis] uteri like a ring, *fornix vaginae,* and opens below and in front by the *orificium vaginae* into the vestibulum vaginae. It possesses an anterior wall, *paries anterior,* and a posterior, *paries posterior,* which lie against one another. At the lower end the cross-section of the lumen is an H-shaped slit. The anterior wall, reaching as far as the labium anterius, is shorter than the posterior.

The wall of the vagina (see Fig. 717) is formed externally of a *tunica muscularis,* which is divisible into an external longitudinal and an internal circular layer. It consists above of smooth muscle fibres, in the trigonum urogenitale of cross-striped fibres. It has, lying loosely upon it within, the thick, grayish-red mucous membrane, *tunica mucosa.* In the virgin this presents, especially below, numerous strong transverse folds, *rugae vaginales,* which in the middle of the anterior and posterior walls form a longitudinal projection, *columna rugarum anterior* and *posterior.* The anterior projection is higher below and is continued in the vestibulum vaginae as far as the orificium urethrae externum as the *carina urethralis [vaginae]* (see Fig. 722). In virgins, going off at the orificium vaginae, chiefly from the posterior wall of the vagina, is a fold of mucous membrane, usually sickle-shaped, the *hymen [femininus]* (see Figs. 719 and 722); it extends forward and upward and narrows the opening. Its margin is smooth or slightly jagged. By sexual intercourse the hymen is torn into several lobules, which shrivel up after the first child-birth into small lobe-like or wart-like projections, *carunculae hymenales* (see Fig. 721).

Vagina (continued).

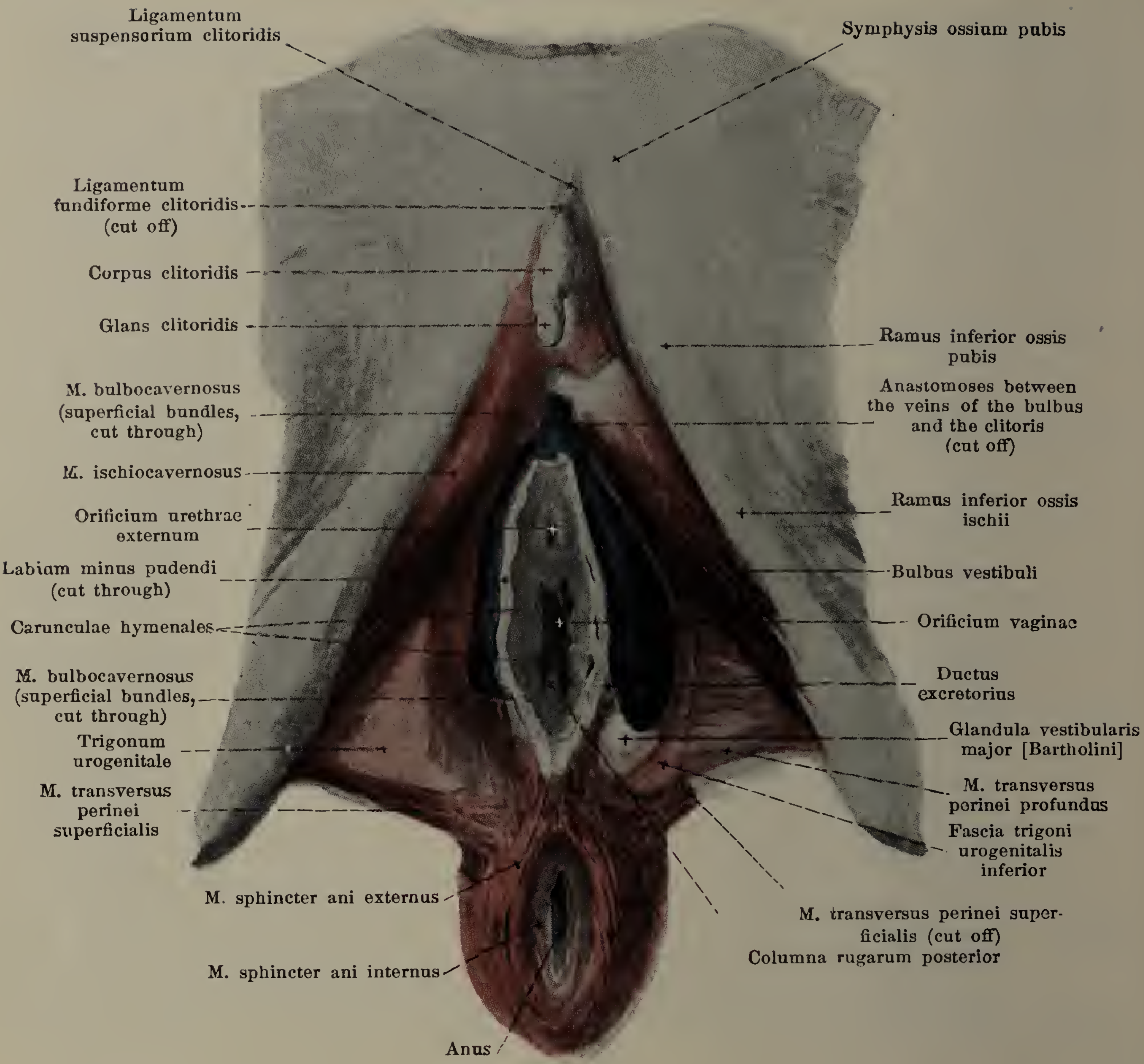
The vagina forms an obtuse angle (see Fig. 719) with the long axis of the cervix uteri and runs below in front of the lower portion of the axis pelvis (see Fig. 206) approximately straight from above and behind, downward and forward. In front it adjoins the fundus of the urinary bladder and urethra and is connected by loose connective tissue with the bladder, by very firm connective tissue with the urethra; above on the lateral portion, the two ureters also lie for some distance on its anterior wall but far more loosely connected (see Fig. 718). Behind, it is covered above as far as the level of the orificium externum uteri by the peritonaeum; it then lies on the anterior surface of the rectum and below goes again away from it; above, it is separated from the rectum by loose connective tissue; below, the musculature of the perineum is shoved in between the two. Laterally on each side above (see also Figs. 522, 523, 553 and 554) the vagina adjoins the parametrium (vide infra), below, it adjoins the medial margin of the m. levator ani; just in front of its opening into the vestibulum it perforates the trigonum urogenitale.

The **female urethra,** *urethra muliebris* (see Figs. 695 and 719), is the channel of exit of the urinary bladder; it begins at the fundus vesicae as the *orificium urethrae internum* (see p. 602) and ends in the vestibulum vaginae upon a small, blunt-wedge-shaped projection as the *orificium urethrae externum,* which as a rule is a sagittal slit. It runs downward and forward in the same way as does the vagina, being curved so as to be a little convex behind. In front and laterally it adjoins the plexus pudendalis, the trigonum urogenitale, which it perforates, and the bulbi vestibuli; behind, it is united with the anterior wall of the vagina immediately below the bladder by means of loose tissue, elsewhere, however, it is very firmly attached.

The wall of the urethra (see Fig. 695) consists externally of a *tunica muscularis,* which is composed of an internal longitudinal layer, *stratum longitudinale,* of smooth muscle fibres and of an external circular layer, *stratum circulare;* the latter is composed internally also by smooth muscle fibres, but externally lie cross-striped muscle fibres, connected with the m. sphincter urethrae membranaceae, which form a closed ring near the bladder only. Internally from this follows a thick, loose *tela submucosa;* it contains large venous networks, which are continued between the layers of muscle and give to them a spongy character, *corpus spongiosum urethrae.* The inner surface is covered by the mucous membrane, *tunica mucosa.* Along the posterior surface, extending from the anterior end of the trigonum vesicae, there is a marked longitudinal fold, *crista urethralis,* which goes as far as the neighborhood of the orificium externum. The lumen is stellate and capable of marked dilatation. The mucous membrane possesses *lacunae urethrales* as in the male (see p. 615) and small tubular glands, which are considered as homologues of the prostatic glands in the male; a large group of these glands opens on each side externally near the orificium urethrae externum through the narrow *ductus paraurethralis* (not drawn).

Course of the peritonaeum in the female pelvis (see Figs. 715 and 718—720).

The relations of the peritonaeum, between the bladder on the one hand, the anterior abdominal wall and the lateral pelvic wall on the other, correspond throughout to those met with in the male (see p. 615). The peritonaeum is reflected from the upper surface of the bladder at the level of the orificium internum uteri upon the facies vesicalis of the corpus uteri (see p. 619), covers this, the fundus and the facies intestinalis of the uterus, then goes over upon the fornix of the vagina, covers its posterior wall as far as the region of the orificium externum uteri and turns to the anterior surface of the rectum. There thus arise two slit-like spaces, the *excavatio vesicouterina* between the bladder and the facies vesicalis uteri and the *excavatio rectouterina [cavum Douglasi]* between the uterus and rectum. The latter space is closed in front by the portio supravaginalis of the cervix uteri and the fornix vaginae, behind by the sacrum and rectum; it ends below in a blind sac in the region of the orificium uteri externum; its upper boundary is formed by two folds of peritonaeum, *plicae rectouterinae [Douglasi]* (see also p. 621), which run from the posterior surface of the cervix uteri near the lateral wall of the rectum to the sacrum; the two go over into one another in front and possess a free concave margin. Arising at the margo lateralis uteri on each side is a duplicature of the peritonaum, *ligamentum latum uteri* (broad ligament of the uterus); it is, when stretched out, quadrangularly-rounded in form (see Fig. 715) and its two layers lie for the most part close to one another. Lateralward and below they deviate from one another and go over into the peritonaeum on the lateral pelvic wall, the bladder and the rectum. They thus bound in front and behind an approximately quadrilateral space (see Fig. 718), which is bounded lateralward by the m. levator ani, medianward by the upper, lateral part of the vagina, as well as by the neck and body of the uterus. This space contains the a. uterina and the ureter, surrounded by the plexus uterovaginalis (see Figs. 553 and 554), all ensheathed in loose, fatty, connective tissue, the *parametrium.* The lateral margin of the ligamentum latum reaches above as far as the v. iliaca externa; going off upward from it in that situation is a fold of peritonaeum, *ligamentum suspensorium ovarii,* which contains the a. and v. ovarica. Passing from the posterior surface is above the short *mesovarium* (see p. 616); the larger, denser portion lying beneath it is called the *mesometrium,* the other, thinner part the *mesosalpinx* (see p. 617). The ligamentum latum turned forward near the bladder lies close to the parietal layer of the peritonaeum.


Ligamentum suspensorium clitoridis
Symphysis ossium pubis
Ligamentum fundiforme clitoridis (cut off)
Corpus clitoridis
Glans clitoridis
Ramus inferior ossis pubis
M. bulbocavernosus (superficial bundles, cut through)
Anastomoses between the veins of the bulbus and the clitoris (cut off)
M. ischiocavernosus
Ramus inferior ossis ischii
Orificium urethrae externum
Labium minus pudendi (cut through)
Bulbus vestibuli
Carunculae hymenales
Orificium vaginae
M. bulbocavernosus (superficial bundles, cut through)
Ductus excretorius
Trigonum urogenitale
Glandula vestibularis major [Bartholini]
M. transversus perinei superficialis
M. transversus perinei profundus
Fascia trigoni urogenitalis inferior
M. sphincter ani externus
M. transversus perinei superficialis (cut off)
Columna rugarum posterior
M. sphincter ani internus
Anus

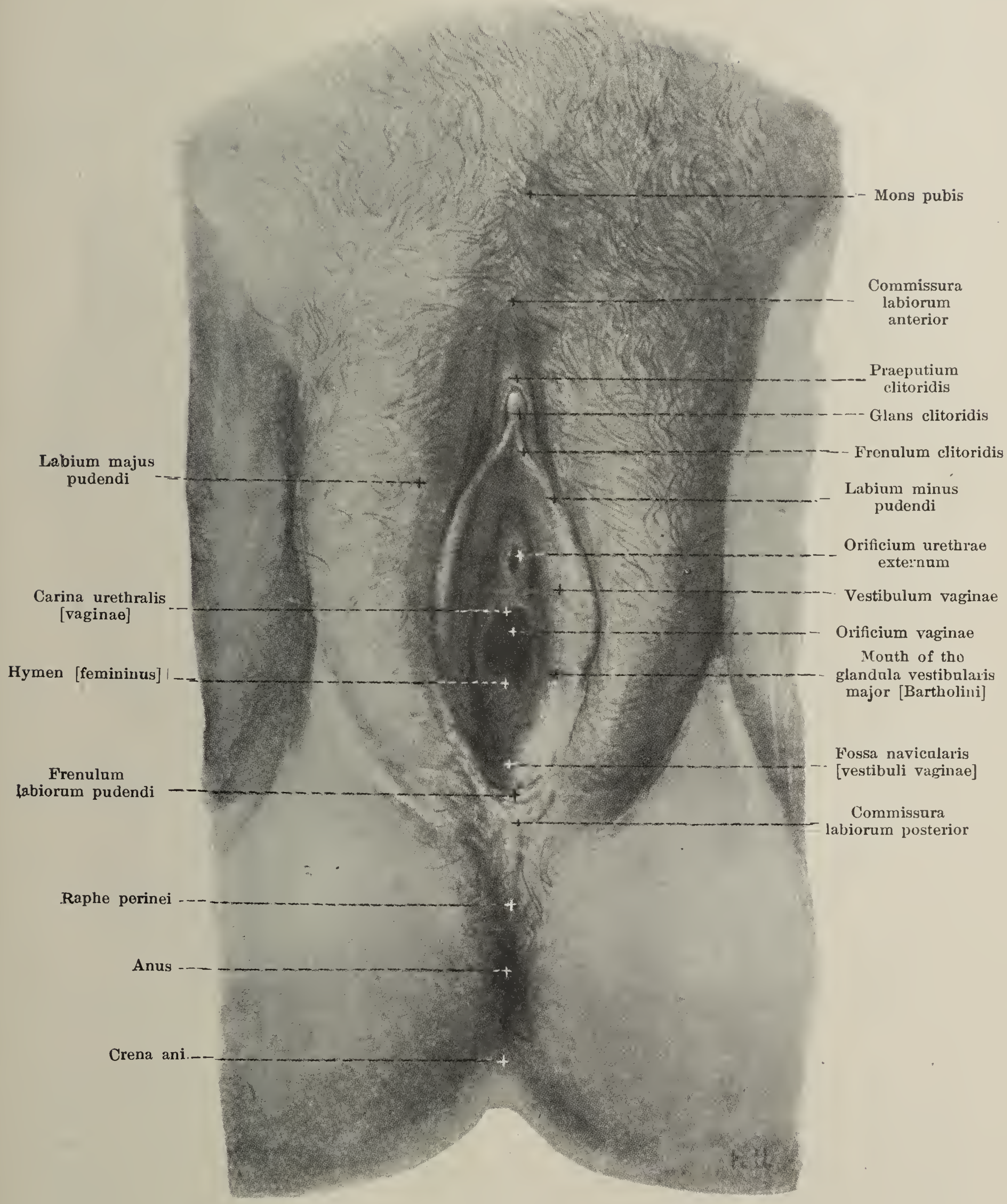
721. **Bulbus vestibuli and trigonum urogenitale,** viewed from below.

(On the left is the m. transversus perinei superficialis and m. bulbocavernosus, on the right the latter is partly removed. On the left the m. transversus perinei profundus is partly exposed.)

The **pudendum muliebre** (O. T. vulva) (see Figs. 718, 719 and 722) lies beneath the trigonum urogenitale and in front of the symphysis ossium pubis; it consists of the labia majora and of the parts which are visible when the vulvar slit is relaxed (see Fig. 722).

The **clitoris** (see also Figs. 554 and 718) corresponds essentially to the corpora cavernosa penis (see pp. 613 and 614), but is much smaller. It consists of two similarly constructed *corpora cavernosa clitoridis*, which, as the *crura clitoridis*, are separated behind, where they exactly resemble the crura penis in position and attachment; they unite in front to form the unpaired, rounded *corpus clitoridis*, which is divided in the median plane by the *septum corporum cavernosorum* and hangs down, even during erection, in a curve in front of the symphysis ossium pubis. The tip of the corpus, *glans clitoridis*, lies free and is covered by external skin. The clitoris is ensheathed by the *fascia clitoridis* and attached by means of the *ligamentum suspensorium clitoridis;* these parts correspond also to those of the penis.

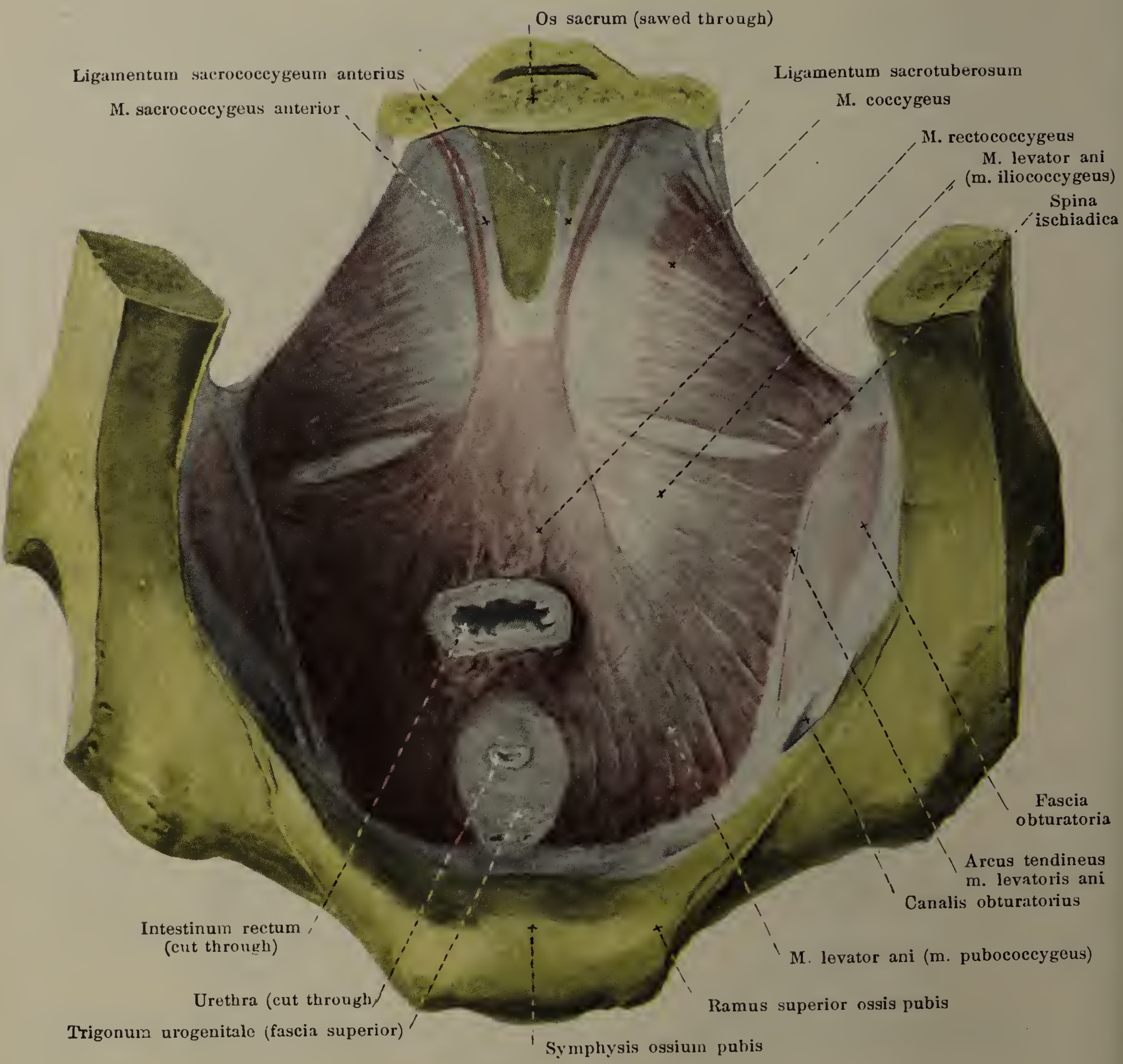
The **bulbus vestibuli** is an oblong body, somewhat pointed in front, somewhat rounded off behind; there is one on each side below the trigonum urogenitale; medianward it adjoins the wall of the vestibulum and introitus vaginae and the glandula vestibularis major; lateralward and below it is covered by the m. bulbocavernosus. It corresponds to the bulbus urethrae of the male (see pp. 613 and 614) and is composed of a plexus of wide, thin-walled veins. Beneath the clitoris the two bulbi are connected with one another and with the veins of the clitoris.


Mons pubis
Commissura labiorum anterior
Praeputium clitoridis
Glans clitoridis
Frenulum clitoridis
Labium majus pudendi
Labium minus pudendi
Orificium urethrae externum
Vestibulum vaginae
Carina urethralis [vaginae]
Orificium vaginae
Hymen [femininus]
Mouth of the glandula vestibularis major [Bartholini]
Fossa navicularis [vestibuli vaginae]
Frenulum labiorum pudendi
Commissura labiorum posterior
Raphe perinei
Anus
Crena ani

722. External genitals of the female.

(The labia have been drawn apart.)

The ***glandula vestibularis major [Bartholini]*** (see also Fig. 721) corresponds in structure, form and size to the glandula bulbourethralis [Cowperi] of the male (see p. 612). It lies on each side lateralward from the posterior part of the vestibulum vaginae partly in the trigonum urogenitale and is partly covered by the posterior end of the bulbus vestibuli and by the m. bulbocavernosus. Its duct opens just laterally to the hymen at the level of the posterior half of the orificium vaginae.

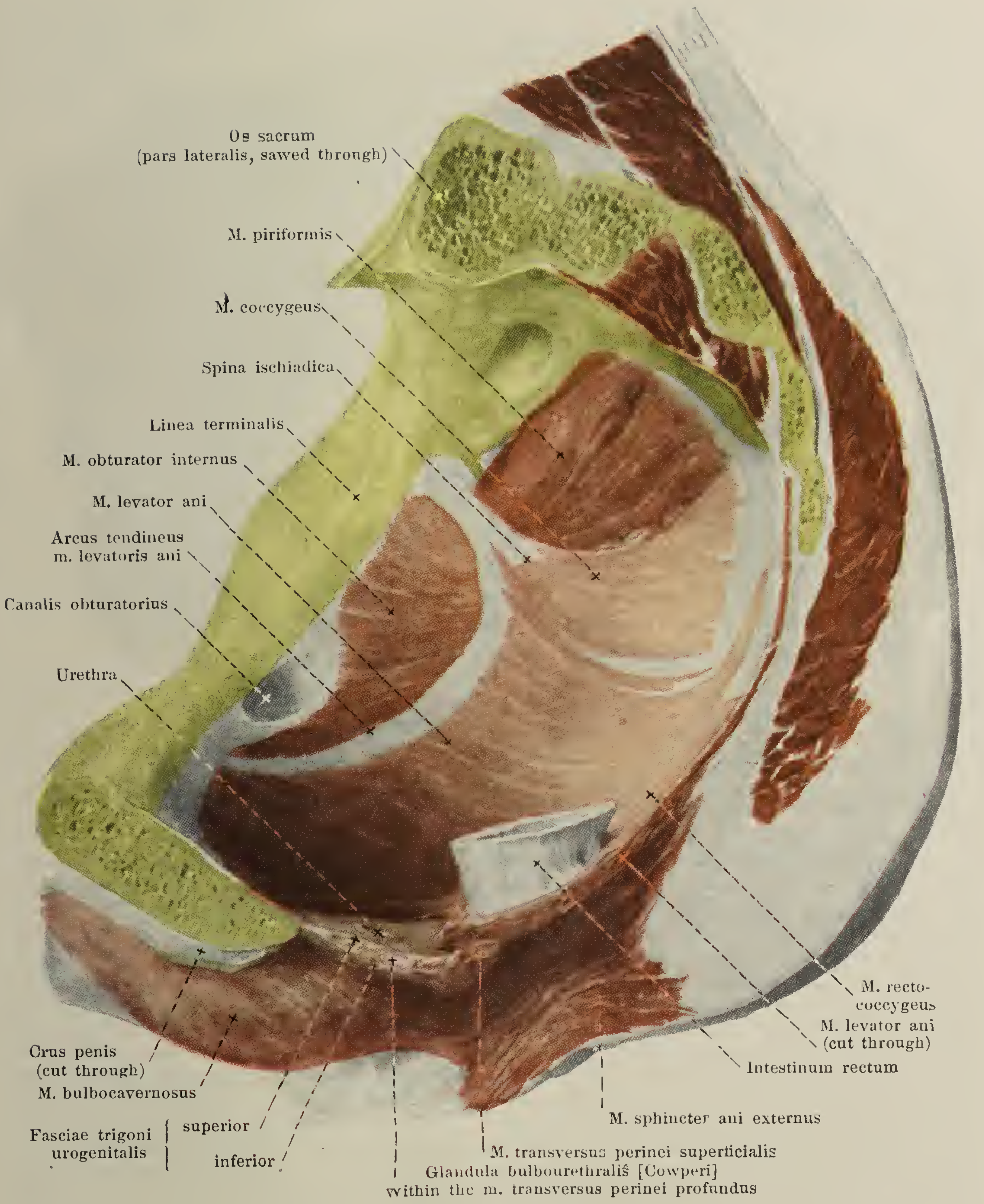

Os sacrum (sawed through)
Ligamentum sacrococcygeum anterius
M. sacrococcygeus anterior
Ligamentum sacrotuberosum
M. coccygeus
M. rectococcygeus
M. levator ani (m. iliococcygeus)
Spina ischiadica
Fascia obturatoria
Arcus tendineus m. levatoris ani
Canalis obturatorius
M. levator ani (m. pubococcygeus)
Ramus superior ossis pubis
Symphysis ossium pubis
Intestinum rectum (cut through)
Urethra (cut through)
Trigonum urogenitale (fascia superior)

723. Mm. levatores ani of the male, viewed from above.

(The prostate has been removed, the rectum cut off short.)

The ***large lips***, *labia majora pudendi* (see Fig. 722), are two large folds of skin, rich in fat, which extend from the upper margin of the symphysis to the perineum and include between them the *rima pudendi* or *pudendal slit*. In front these folds go over into one another forming the *commissura labiorum anterior;* behind they are either connected with one another forming the *commissura labiorum posterior*, or they may remain separated by a groove. Lateralward they are bounded by furrows in the skin; their anterior surface is covered with pubic hairs, *pubes*. The skin of the labia majora contains many sweat glands and large sebaceous glands.

The ***small lips***, *labia minora pudendi* (see Figs. 718, 719 and 722), are two thinner, cockscomb-like, reddish folds which enclose the *vestibulum vaginae* and are ordinarily not visible when the pudendal slit is closed. They are separated from the labia majora by a groove. They unite behind in women who have not borne children, usually forming a delicate fold, *frenulum labiorum pudendi*, behind which lies a fossa, *fossa navicularis [vestibuli vaginae]*. In front they divide into two limbs; the external limbs unite over the glans clitoridis to form the gable-like *praeputium clitoridis*, the internal limbs become attached together to the under surface of the glans clitoridis as the *frenulum clitoridis*. In the vestibulum, especially between the urethral and the vaginal opening, small glands, *glandulae vestibulares minores*, occour.


Os sacrum
(pars lateralis, sawed through)
M. piriformis
M. coccygeus
Spina ischiadica
Linea terminalis
M. obturator internus
M. levator ani
Arcus tendineus m. levatoris ani
Canalis obturatorius
Urethra
Crus penis (cut through)
M. bulbocavernosus
Fasciae trigoni urogenitalis
superior
inferior
Glandula bulbourethralis [Cowperi] within the m. transversus perinei profundus
M. transversus perinei superficialis
M. sphincter ani externus
Intestinum rectum
M. levator ani (cut through)
M. recto-coccygeus

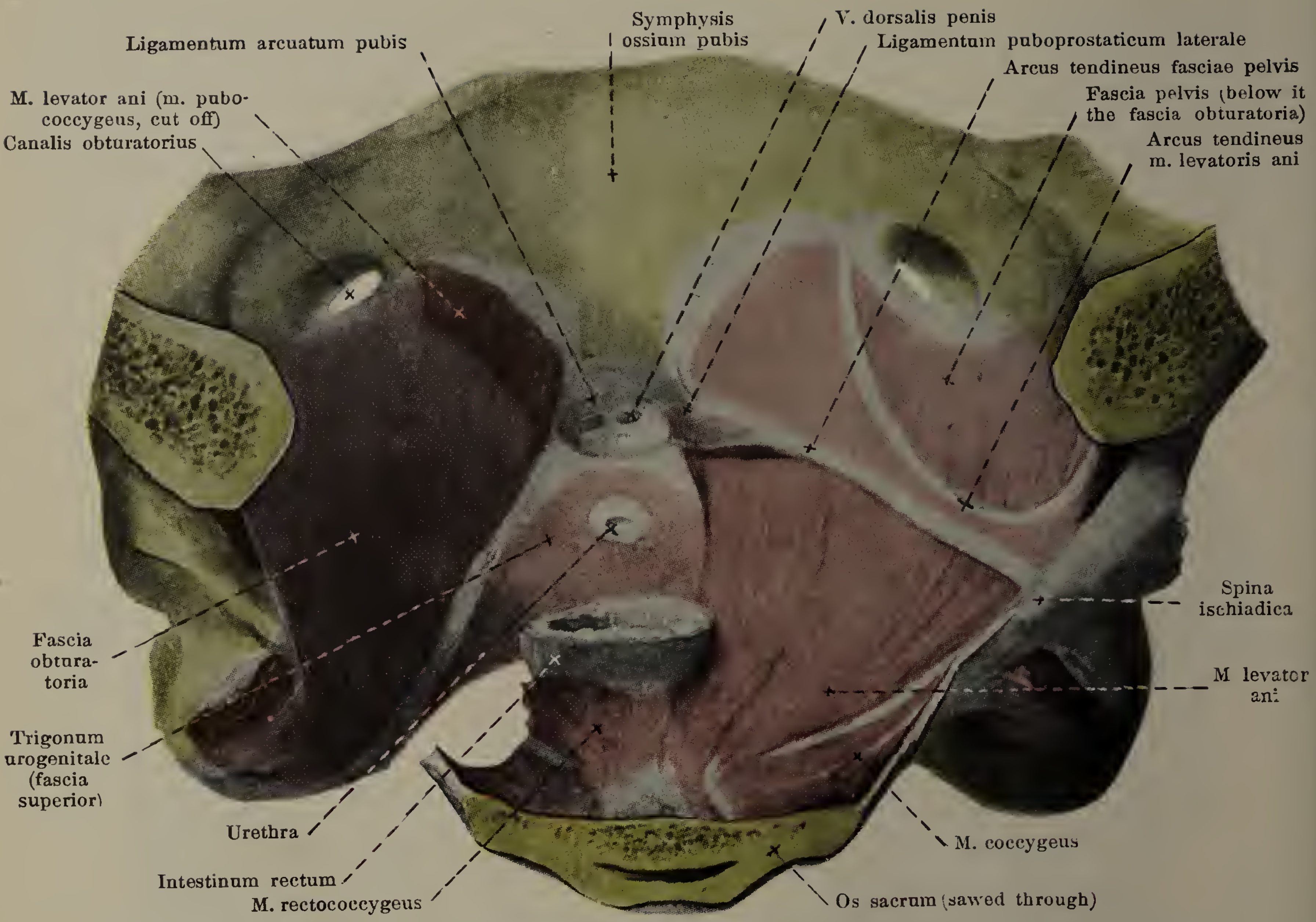
724. Right m. levator ani in the male, viewed from the left.

(The pelvis has been cut through on the left side near the median plane; the prostate is removed, the bowel cut off.)

The floor of the small pelvis is formed chiefly by the **diaphragma pelvis;** this is composed of the two mm. levatores ani and coccygei and has the form of a funnel, the deepest point of which lies below in the pars analis recti.

M. coccygeus (see p. 346).

M. levator ani (see also Figs. 723, 725, 727, 728 and 730), paired. Form: quadrangular, thin, flat, separable in two portions, *m. pubococcygeus* and *m. iliococcygeus.* Innervation: branches of the plexus pudendus ([S_2] S_3, S_4). (Continuation see p. 628.)


Ligamentum arcuatum pubis
Symphysis ossium pubis
V. dorsalis penis
Ligamentum puboprostaticum laterale
Arcus tendineus fasciae pelvis
Fascia pelvis (below it the fascia obturatoria)
Arcus tendineus m. levatoris ani
M. levator ani (m. pubococcygeus, cut off)
Canalis obturatorius
Spina ischiadica
M levator ani
Fascia obturatoria
Trigonum urogenitale (fascia superior)
Urethra
Intestinum rectum
M. rectococcygeus
M. coccygeus
Os sacrum (sawed through)

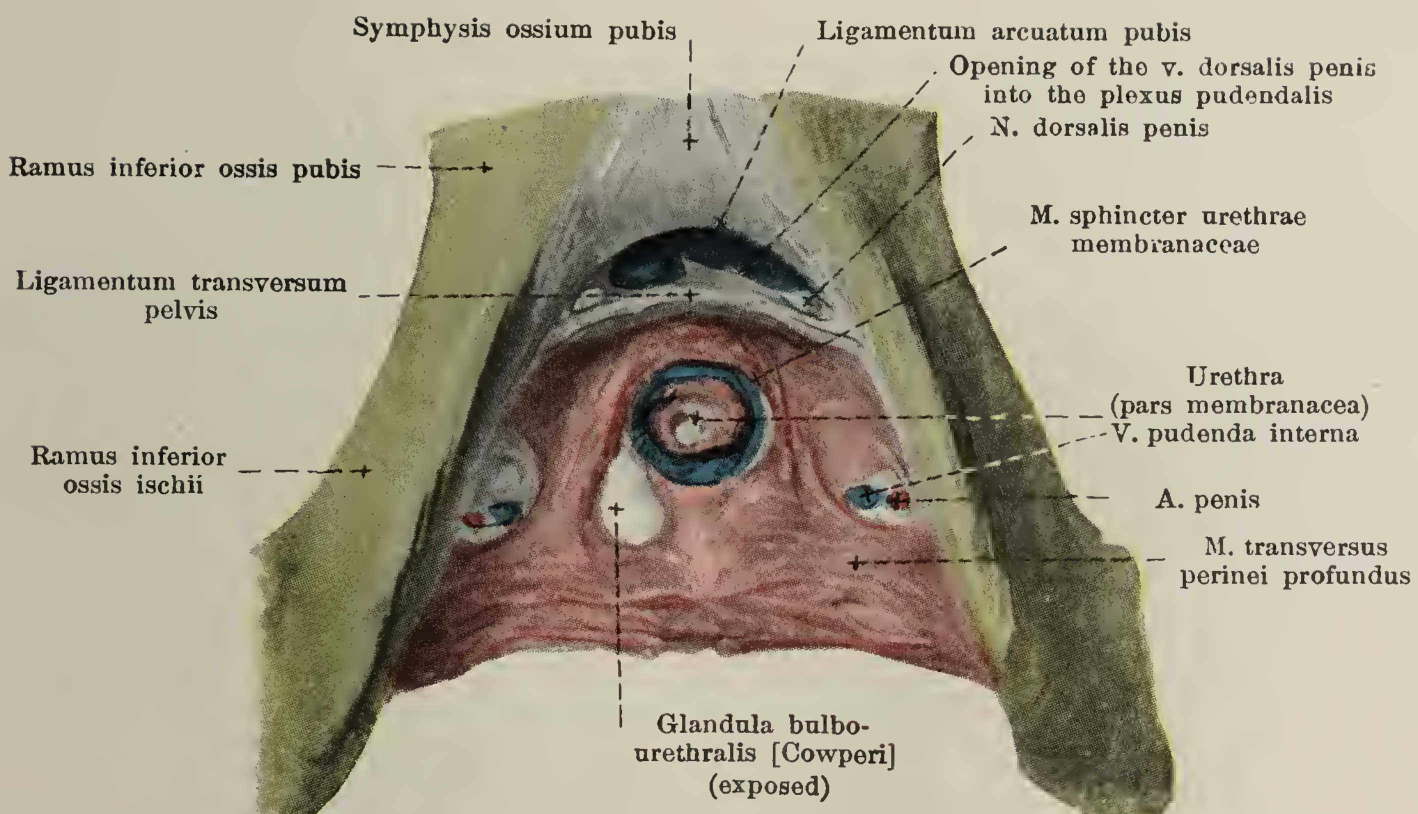
725. Right m. levator ani and trigonum urogenitale of the male, viewed from behind and above.

M. pubococcygeus. Origin: from the posterior surface of the rami ossis pubis in a narrow curved area (which in front surrounds the origin of the m. obturator internus) and from the most anterior portion of the arcus tendineus m. levatoris ani (vide infra); a few fibres also from the anterior part of the arcus tendineus fasciae pelvis. Insertion: the fibres run backward, downward and medianward near the prostate in the male, near the urethra and vagina in the female and near the rectum; partly they go to a tendinous plate, which goes over into the ligamentum sacrococcygeum anterius; partly they interweave between the rectum and the coccyx with the fibres of the other side; only a few fibres go to the wall of the rectum and run in its anterior, lateral portion to the skin. Behind the rectum the m. rectococcygeus (see p. 546) lies directly above this muscle. Action of the muscles of the two sides together: they narrow the pars analis recti (and in the female the vagina), draw the rectum forward and upward, and elevate the floor of the pelvis.

M. iliococcygeus. Origin: from an arch, *arcus tendineus m. levatoris ani*, convex downward, interwoven in the fascia obturatoria; the anterior end of the arch begins on the posterior surface of the ramus superior ossis pubis, and the posterior end can be followed as far as the linea arcuata of the ilium; between these two points it descends for a variable distance but always leaves free the canalis obturatorius. Insertion: the fibres run medianward and downward, pass beneath the posterior portion of the m. pubococcygeus and also often overlap the m. coccygeus from above; the anterior fibres between the anus and the tip of the coccyx form tendinous connections with the fibres of the other side, the posterior fibres go to the margin of the os coccygis. Action of the muscles of the two sides together: they elevate the floor of the pelvis.

M. sacrococcygeus anterior (see Fig. 723), paired, present very often. Form: narrow, thin. Position: on the upper surface of the m. coccygeus. Origin: anterior surface of the 3rd or 4th sacral vertebra. Insertion: ligamentum sacrococcygeum anterius. Innervation: branches of the plexus coccygeus (S_4, S_5).

M. sacrococcygeus posterior (not illustrated), paired, very variable. Thin muscle bundles upon the posterior surface of the lower sacral and upper coccygeal vertebrae. Innervation: branch of the plexus coccygeus.


Symphysis ossium pubis
Ligamentum arcuatum pubis
Opening of the v. dorsalis penis into the plexus pudendalis
N. dorsalis penis
Ramus inferior ossis pubis
M. sphincter urethrae membranaceae
Ligamentum transversum pelvis
Urethra (pars membranacea)
V. pudenda interna
Ramus inferior ossis ischii
A. penis
M. transversus perinei profundus
Glandula bulbourethralis [Cowperi] (exposed)

726. Muscles of the trigonum urogenitale of the male, viewed from below.

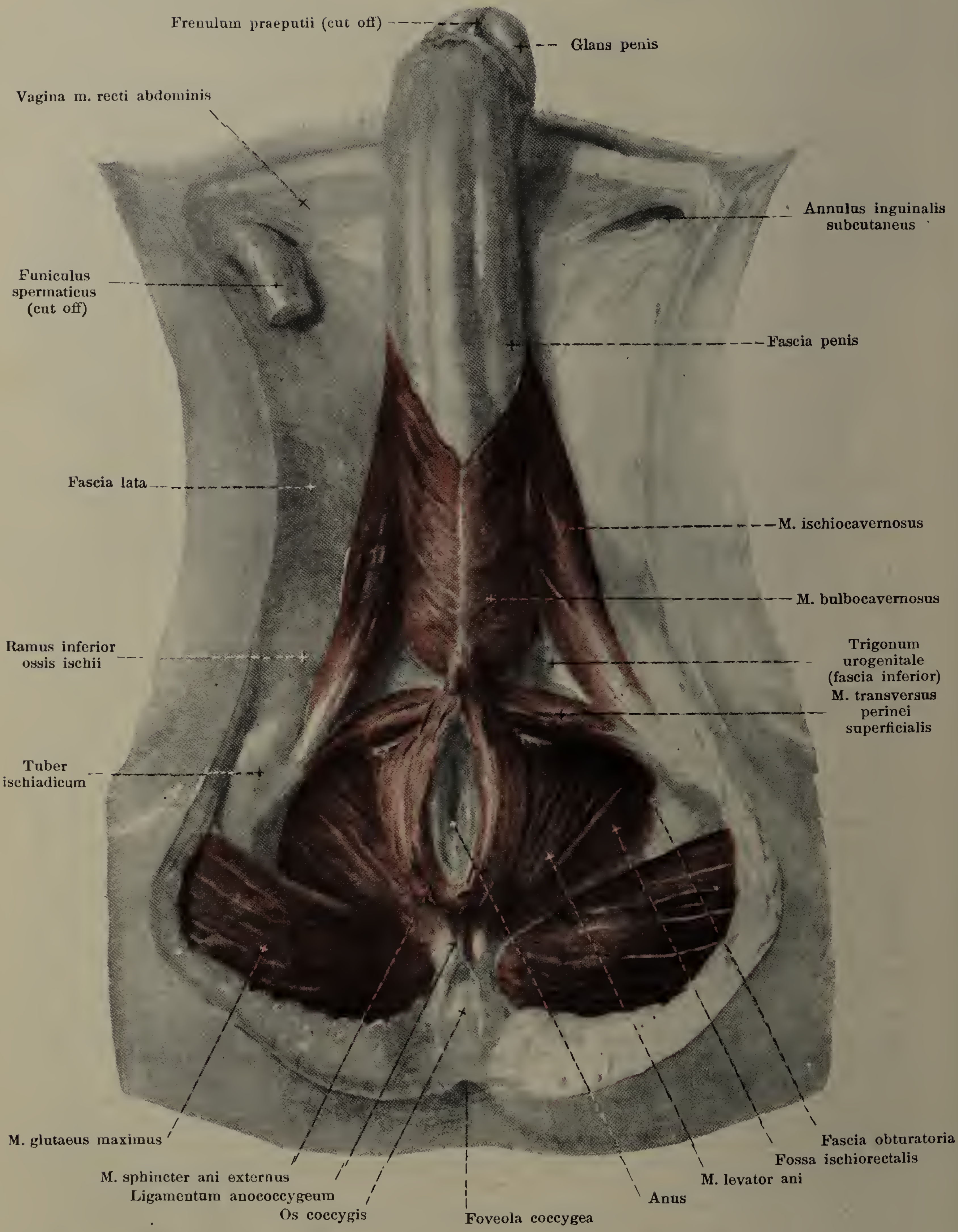
(The fascia inferior has been removed, on the right side the glandula bulbourethralis has been exposed.)

The **trigonum *(diaphragma)* urogenitale** (O. T. triangular ligament) (see Figs. 693, 709—711, 721, 724, 725, 727, 728 and 730) is a firm, trapezoid, musculo-tendinous plate which fills up the space between the rami inferiores of the ischial and pubic bones, beneath the two mm. pubococcygei, so that only a space is left free in front, just beneath the ligamentum arcuatum pubis for the passage of the v. dorsalis penis (clitoridis). It ends behind in a thin, slightly concave curved margin, in front in a sharp margin and is perforated perpendicularly by the pars membranacea of the urethra in the male, the urethra and the vagina in the female.

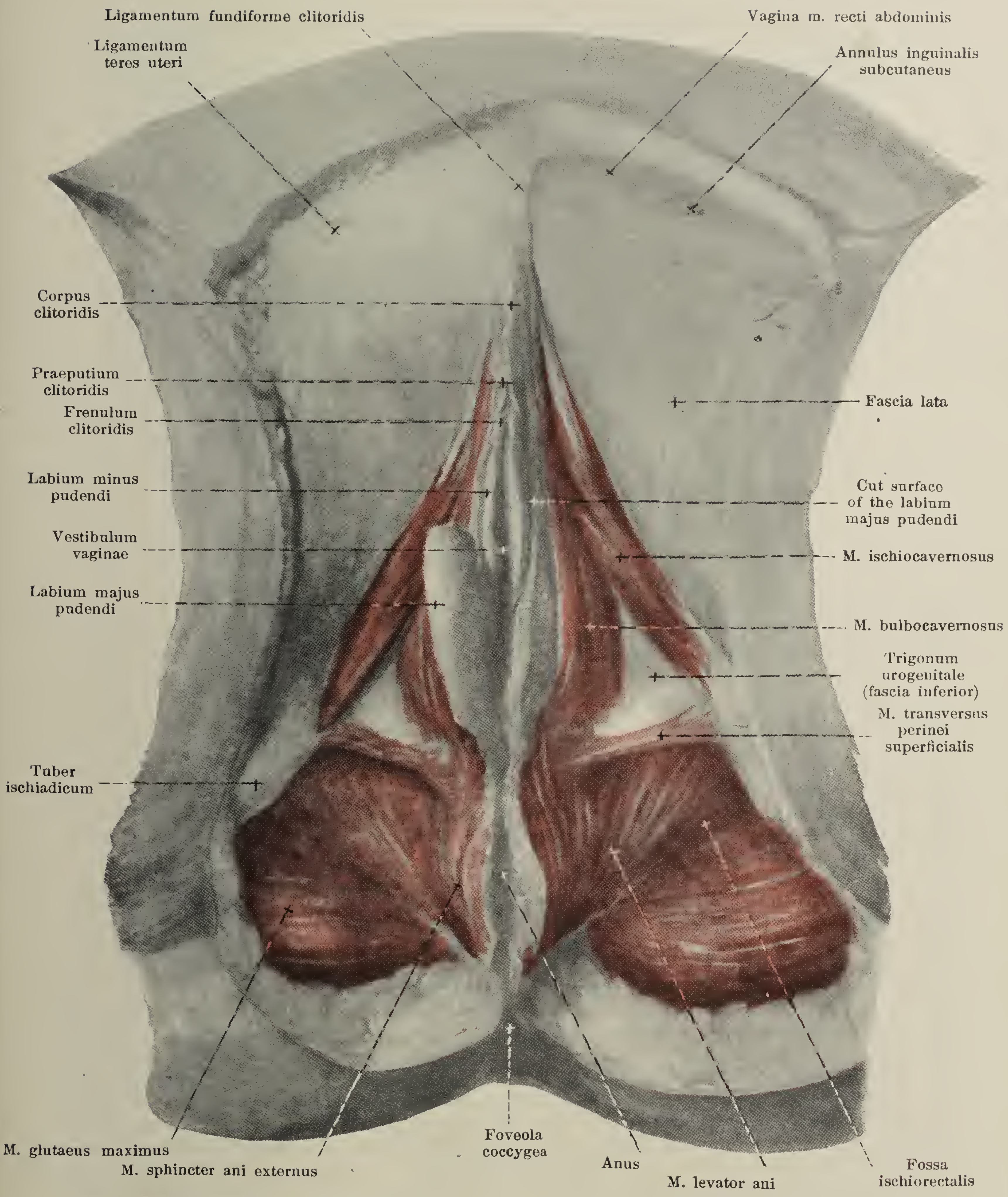
The trigonum urogenitale consists of two strong layers, the *fascia trigoni urogenitalis superior* (O. T. posterior layer of triangular ligament, deep or superior triangular ligament), and *fascia trigoni urogenitalis inferior* (O. T. anterior layer of the triangular ligament, superficial or inferior triangular ligament). These are fused with one another at their anterior and posterior margins and enclose a flat slit-like space. Through the fusion of their anterior margins there is formed a firm cord, *ligamentum transversum pelvis*, which is stretched transversely from one pubic bone to the other; the region of fusion of the posterior margins is less pronounced and is covered on its inferior surface by the m. transversus perinei superficialis. The compartment between the two fasciae is filled up by the *m. transversus perinei profundus*, the *m. sphincter urethrae membranaceae*, the glandulae bulbourethrales in the male, a part of the glandulae vestibulares majores in the female; in the grooves at the two sides run the aa. penis (clitoridis), vv. pudendae internae and nn. dorsales penis (clitoridis). The two fasciae arise from the lower rami of the ischium and os pubis, are strongest lateralward and are connected medianward with the wall of the urethra (and vagina); the upper is continued also into the fascia prostatae.

M. transversus perinei profundus. Form: flat. Position: in the posterior part of the trigonum urogenitale. Origin: rami inferiores ossis ischii. Insertion: the fibres run to the median plane and there, becoming tendinous, interweave with one another. Innervation: n. dorsalis penis (clitoridis) (S_3).

M. sphincter urethrae membranaceae. a) In the *male.* Its innermost fibres surround the urethra as an uninterrupted circular layer and are directly connected proximalward with the m. prostaticus, distalward with circular fibres of the pars cavernosa urethrae. The external fibres arise from the angle of junction of the crura penis, from the ligamentum transversum pelvis, from the fasciae trigoni and from the rami inferiores of the pubic bones; they surround the urethra and the glandulae bulbourethrales in arches and, becoming tendinous, unite with one another behind in the median plane. Action: it compresses the urethra and the glandulae bulbourethrales. b) In the *female.* The innermost fibres run similar to those in the male, forming a ring around the urethra. The external fibres arise from the ligamentum transversum pelvis, the fasciae trigoni and the pubic bones and extend in arches or straight to the junction between the urethra and the vagina or become attached to the wall of the vagina; they pass through and partly cover over the glandulae vestibulares majores. Innervation: nn. dorsales penis (clitoridis) (S_3).


Frenulum praeputii (cut off)
Glans penis
Vagina m. recti abdominis
Annulus inguinalis subcutaneus
Funiculus spermaticus (cut off)
Fascia penis
Fascia lata
M. ischiocavernosus
M. bulbocavernosus
Ramus inferior ossis ischii
Trigonum urogenitale (fascia inferior)
M. transversus perinei superficialis
Tuber ischiadicum
M. glutaeus maximus
M. sphincter ani externus
Ligamentum anococcygeum
Os coccygis
Foveola coccygea
Anus
M. levator ani
Fossa ischiorectalis
Fascia obturatoria

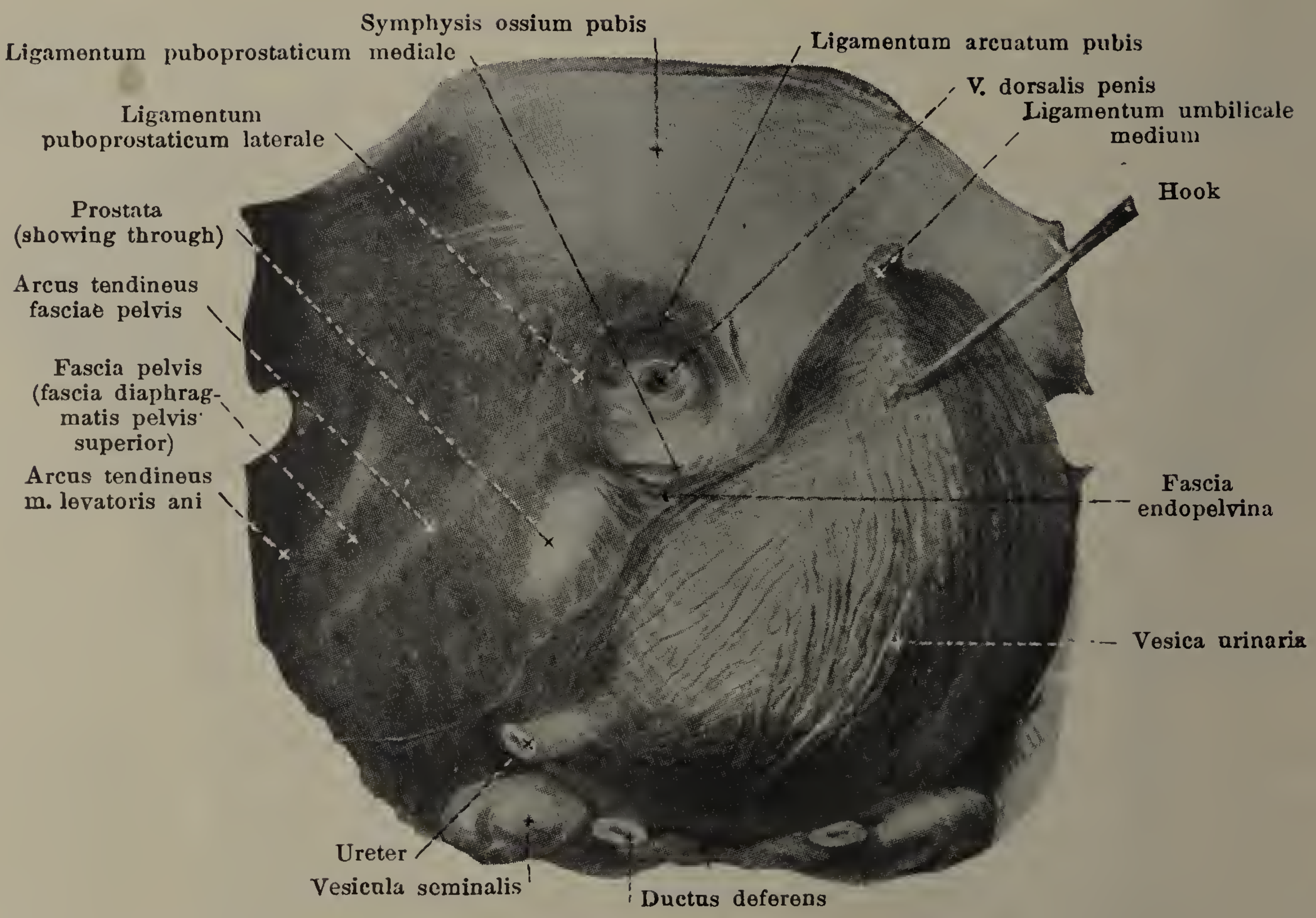
727. Muscles of the male perineum,
viewed from below.



728. Muscles of the female perineum, viewed from below.

(On the right side the posterior part of the labium majus has been left in situ.)

M. transversus perinei superficialis (see also Figs. 721 and 727), paired, very variable. Form: narrow, rounded or flattened. Position: below the posterior margin of the trigonum urogenitale. Origin: medial margin of the ramus inferior ossis ischii, above or below the origin of the m. ischiocavernosus. Insertion: the fibres run medianward to the region between the anus and the urogenital canal; there, undergoing partial decussation, they run to the raphe of the m. bulbocavernosus, to the trigonum urogenitale and, in the depth, very often also to the m. sphincter ani externus of the other side. Innervation: n. perinei (S_3).

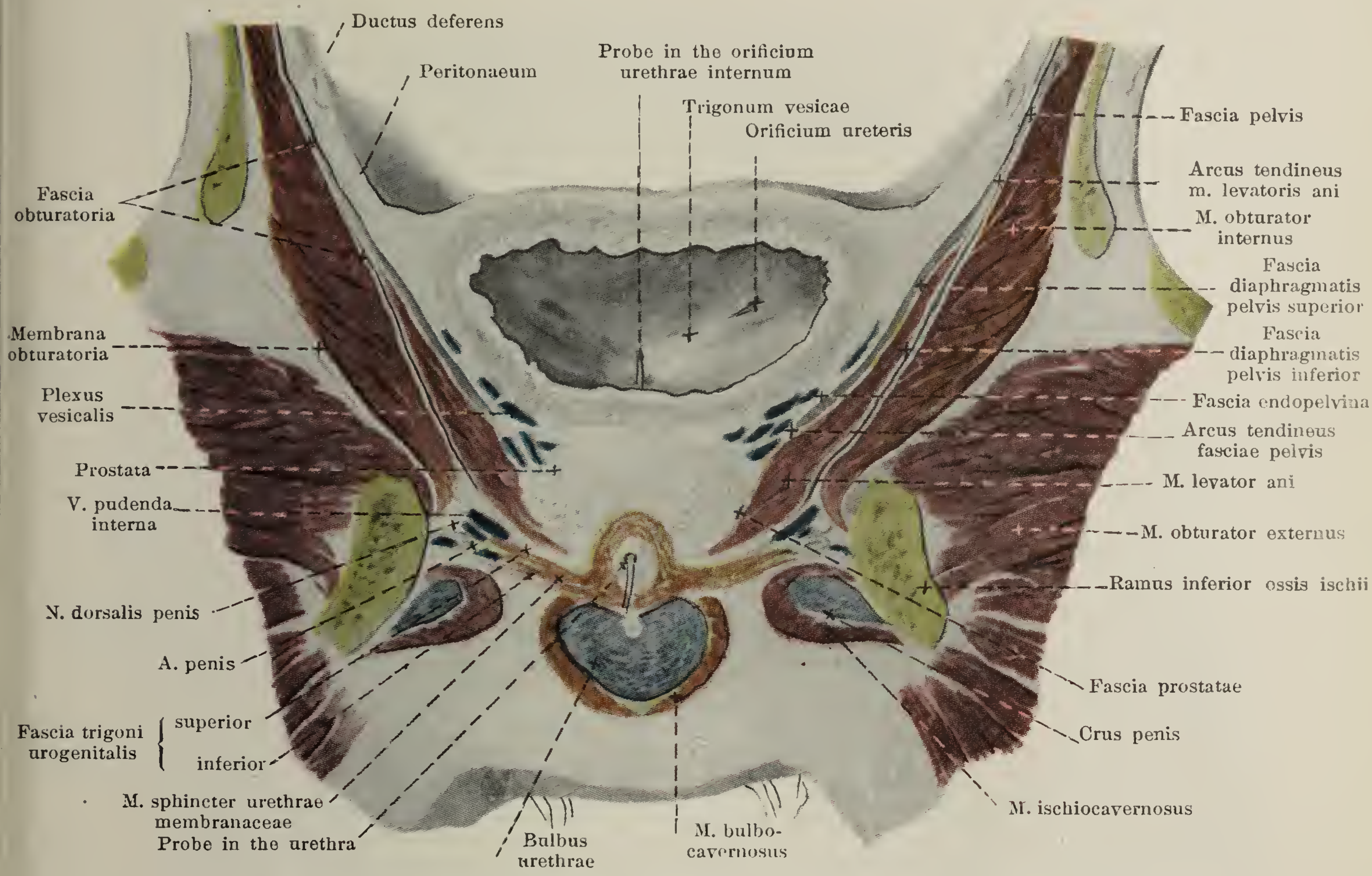

Symphysis ossium pubis
Ligamentum puboprostaticum mediale
Ligamentum arcuatum pubis
V. dorsalis penis
Ligamentum umbilicale medium
Ligamentum puboprostaticum laterale
Hook
Prostata (showing through)
Arcus tendineus fasciae pelvis
Fascia pelvis (fascia diaphragmatis pelvis superior)
Arcus tendineus m. levatoris ani
Fascia endopelvina
Vesica urinaria
Ureter
Vesicula seminalis
Ductus deferens

729. Ligamenta puboprostatica, viewed from above and behind. (The urinary bladder has been drawn to the right, its musculature has for the most part been exposed.)

M. sphincter ani externus (see Figs. 629, 721, 724, 727 and 728), unpaired. Form: oval, thick. Position: external from the m. sphincter ani internus, encircling the anus and the annulus haemorrhoidalis; above it is directly continuous with the mm. pubococcygei. Origin and insertion: the more superficial fibres arise behind the anus, partly crossed, from the skin or, through the mediation of a strand of connective tissue, ***ligamentum anococcygeum***, from the posterior surface and the tip of the coccyx, and end in front of the anus, crossed and uncrossed, in the skin and in the raphe of the m. bulbocavernosus. The deep, thicker fibre mass is circular; its fibres partly decussate in front and behind; see also p. 631. Action: it closes the anus. Innervation: nn. haemorrhoidales inferiores (S_3, S_4).

M. ischiocavernosus (O. T. erector penis in the male, ischiocavernosus in the female), paired. a) In the *male* (see Figs. 708, 710, 711, 727 and 730). Form: oblong, groove-like, thicker in the middle, where it is fleshy; tendinous in front and behind. Position: below and medianward it embraces the crus penis; it is adjacent above to the trigonum urogenitale, medianward to the m. bulbocavernosus; behind it reaches as far as the posterior margin of the trigonum urogenitale. Origin: medial surface of the ramus inferior ossis ischii. Insertion: the fibres go forward partly to the medial and inferior surfaces of the crus penis, partly lateralward to the dorsum penis and, becoming tendinous, are attached to the tunica albuginea. Action: it makes the tunica albuginea tense and helps in erection and ejaculation. b) In the *female* (see Figs. 721 and 728) it is feebler, but otherwise resembles that of the male. Innervation: n. perinei (S_3).

M. bulbocavernosus (O. T. accelerator urinae). a) In the *male* (see Figs. 709, 724, 727 and 730), unpaired. Form: groove-like. Position: ensheaths the free surface of the bulbus urethrae, is adjacent above the trigonum urogenitale, lateralward to the mm. ischiocavernosi. Origin: from the median tendinous raphe, which lies on the lower and posterior surface of the bulbus urethrae. Insertion: the fibres run in curves on each side forward and upward; the anterior more superficial fibres embrace the corpus penis and end upon its dorsum in the fascia penis; the deeper fibres go partly to the angle of junction of the crura penis, partly they encircle the bulbus (see Fig. 711). b) In the *female* (see Figs. 718 and 728) divided behind into two symmetrical halves. Position: directly on the lateral surface of the bulbus vestibuli and the glandula vestibularis major; otherwise as in the male. Origin: most posterior portion of the trigonum urogenitale. Insertion: the more superficial fibres go to the dorsum clitoridis, the deeper fibres embrace the bulbus vestibuli and go to the angle of junction of the crura clitoridis (see Fig. 721). The muscle is frequently connected, especially in the female, with the m. sphincter ani externus of the same side. Action: it compresses the bulbi (and glandulae vestibulares majores) and helps in erection and ejaculation. Innervation: nn. perinei (S_3).



730. Frontal section through the male pelvis.

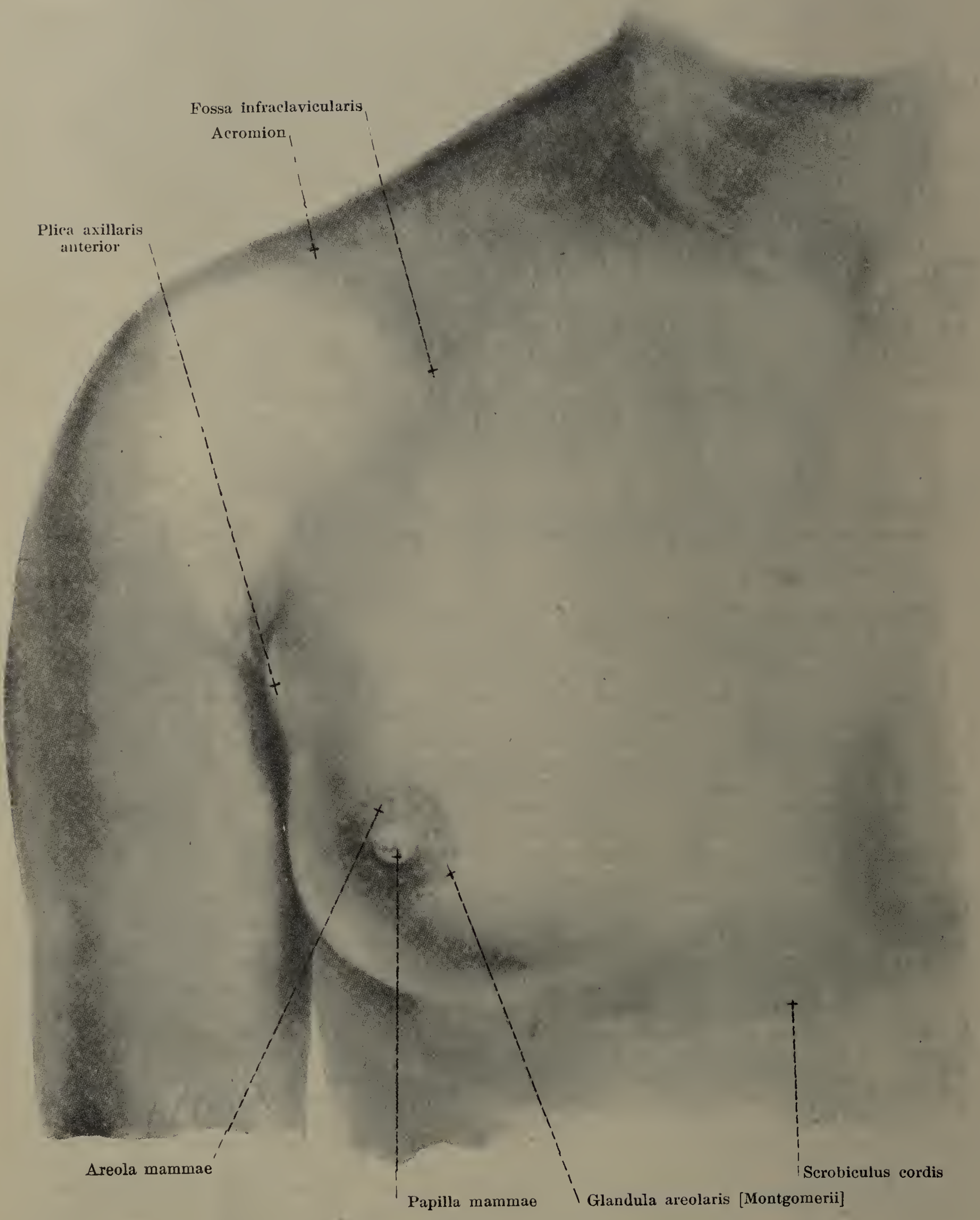
(After a frozen section by W. Braune. The posterior part is viewed from in front.)

Fascia obturatoria (obturator fascia) (see also Figs. 723 and 725) is a very strong fascia which covers the medial surface of the m. obturator internus and is everywhere attached at its border to the bone; interwoven in it is the arcus tendineus m. levatoris ani (see p. 628).

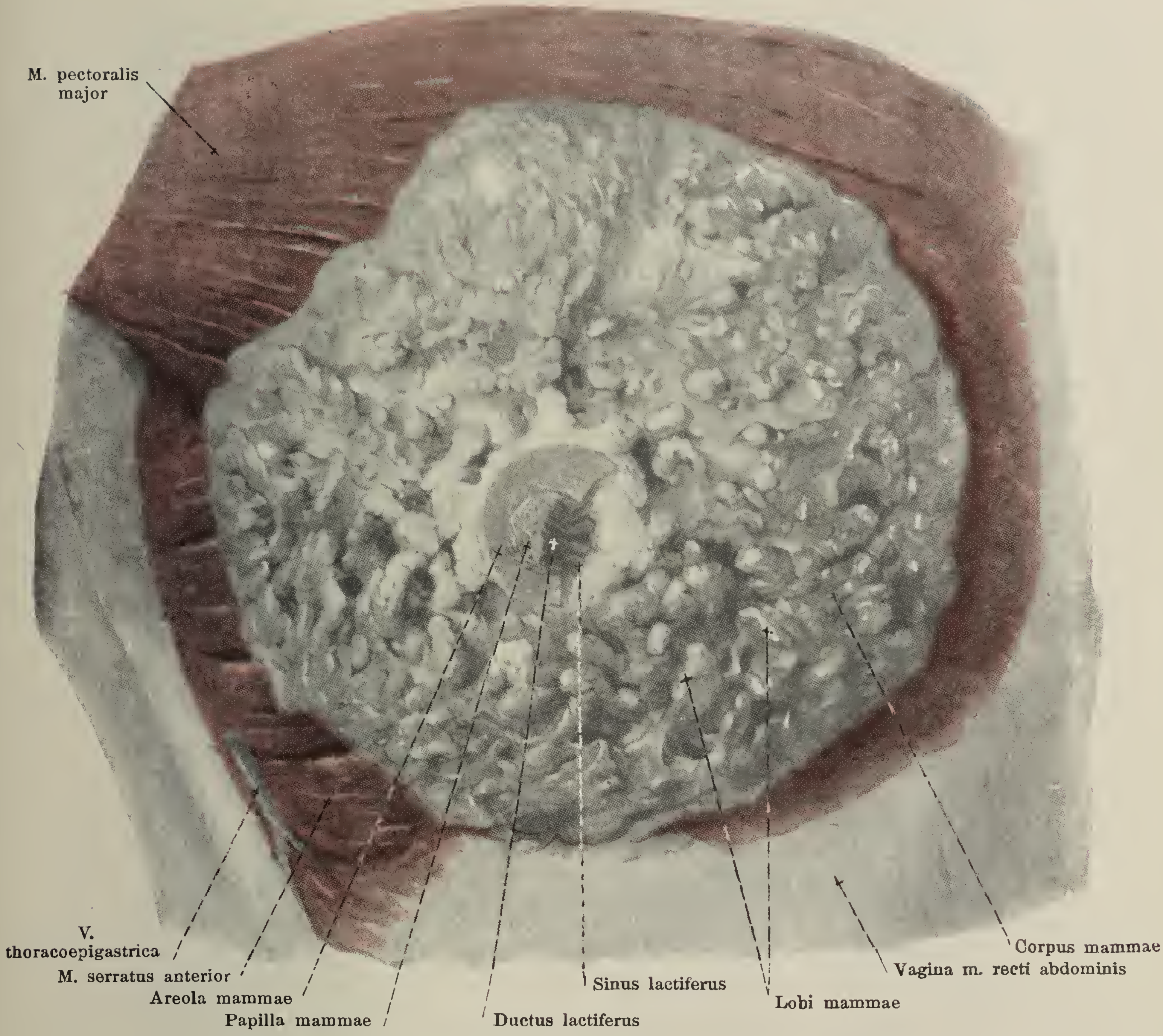
Fascia pelvis (pelvic fascia) (see also Figs. 725 and 729) is connected above at the linea terminalis with the fascia transversalis and the fasciae iliacae. As a thin membrane it covers at first the inner surface of the bones and of the fascia obturatoria, then becomes stronger and as the *fascia diaphragmatis pelvis superior* covers the medial, upper surface of the diaphragma pelvis downward as far as a tough tendinous strip of connective tissue, *arcus tendineus fasciae pelvis* (O. T. white line), which runs in it on each side from the lowermost portion of the symphysis ossium pubis backward and lateralward to the spina ischiadica. At this strip the main mass of the fascia goes over upon the pelvic viscera and, as the *fascia endopelvina,* covers the urinary bladder, the vagina and the rectum, along with their venous plexuses, gradually becoming lost above. Other bands of fascia extend from the arcus tendineus fasciae pelvis on the medial surface of the diaphragma pelvis in the male as far as the tip of the prostate and there go over into the fascia prostatae (in the female they go to the vagina and the urethra). Between the anterior ends of the two arcus tendinei fasciae pelvis, the fascia descends somewhat deeper and thus forms a fossa which is bounded lateralward by two projecting strips, the *ligamenta puboprostatica* (in the female *pubovesicalia) lateralia* (O. T. lateral true ligaments of the bladder) and in its depth runs the *ligamentum puboprostaticum* (in the female *pubovesicale) medium* (O. T. anterior true ligament of the bladder). These ligaments run out from the posterior surface of the lowermost portion of the symphysis in the male to the urinary bladder and prostate, in the female to the urinary bladder and urethra, and contain in their depth bands of smooth muscle fibres, *mm. pubovesicales.*

The lateral, lower surface of the diaphragma pelvis is covered by the thin *fascia diaphragmatis pelvis inferior*, which is connected with the fascia obturatoria above. The wedge-shaped space (see Figs. 727 and 728) situated between it and the fascia obturatoria, filled by fat, vessels and nerves, is called the *fossa ischiorectalis.*

The *fascia superficialis perinei* (O.T.fascia of Colles) (not illustrated) begins at the posterior margin of the trigonum urogenitale, covers the radix penis and its muscles, is connected lateralward with the bone and goes over in front into the tunica dartos and into the fascia penis.



731. Right breast of a girl, eighteen years old.

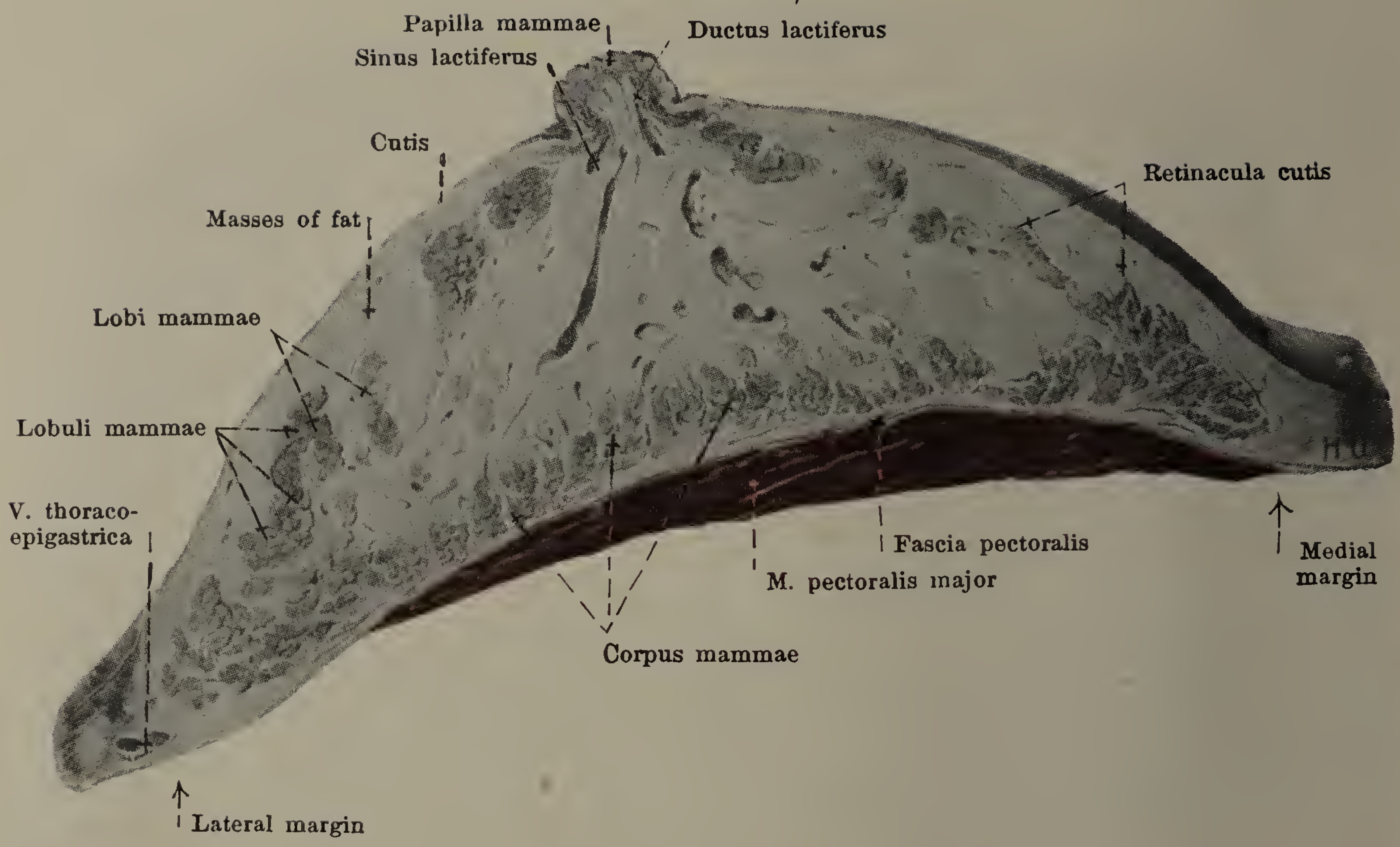


732. Right breast of a woman in advanced pregnancy,

dissected out, in its natural position as regards the thoracic muscles.

The **breasts,** ***mammae*** (see also Figs. 731 and 733), come to full development in the female only; in the male they remain rudimentary troughout life. They are paired, and are very differently developed and formed according to race, individual and the functional condition of the gland.

A well-formed, firm elastic breast represents a segment of a sphere which projects a little more below than above. At about the height of the convexity projects the *nipple of the breast, papilla mammae,* variable in height; in nulliparae this is wedge-shaped or cylindrical. Its apex is rough and fissured and contains in its depressions the openings of the milk ducts; its circumference is covered with wrinkles. It is surrounded by a circular area, also wrinkled, the *areola mammae;* this presents, especially during pregnancy, several rounded elevations of the size of a head of a pin, which are due to the glandulae areolares. When the breasts are well developed their bases reach from the third to the sixth, rarely as far as the seventh, rib and are separated from one another in the middle by a furrow, the *bosom,* corresponding to the sternum. In nulliparae the breasts are obliquely placed, that is the nipples are directed somewhat lateralward. They project lateralward beyond the margin of the m. pectoralis major and beyond the anterior axillary fold corresponding to it, the *plica axillaris anterior.* The nipple, when the breast is firmly seated, is situated at the level of the 5th rib; the level on the right and left side frequently varies and the two nipples vary in their distance from the median plane.



733. Horizontal section through the right breast of a woman in advanced pregnancy, upper half, viewed from below.

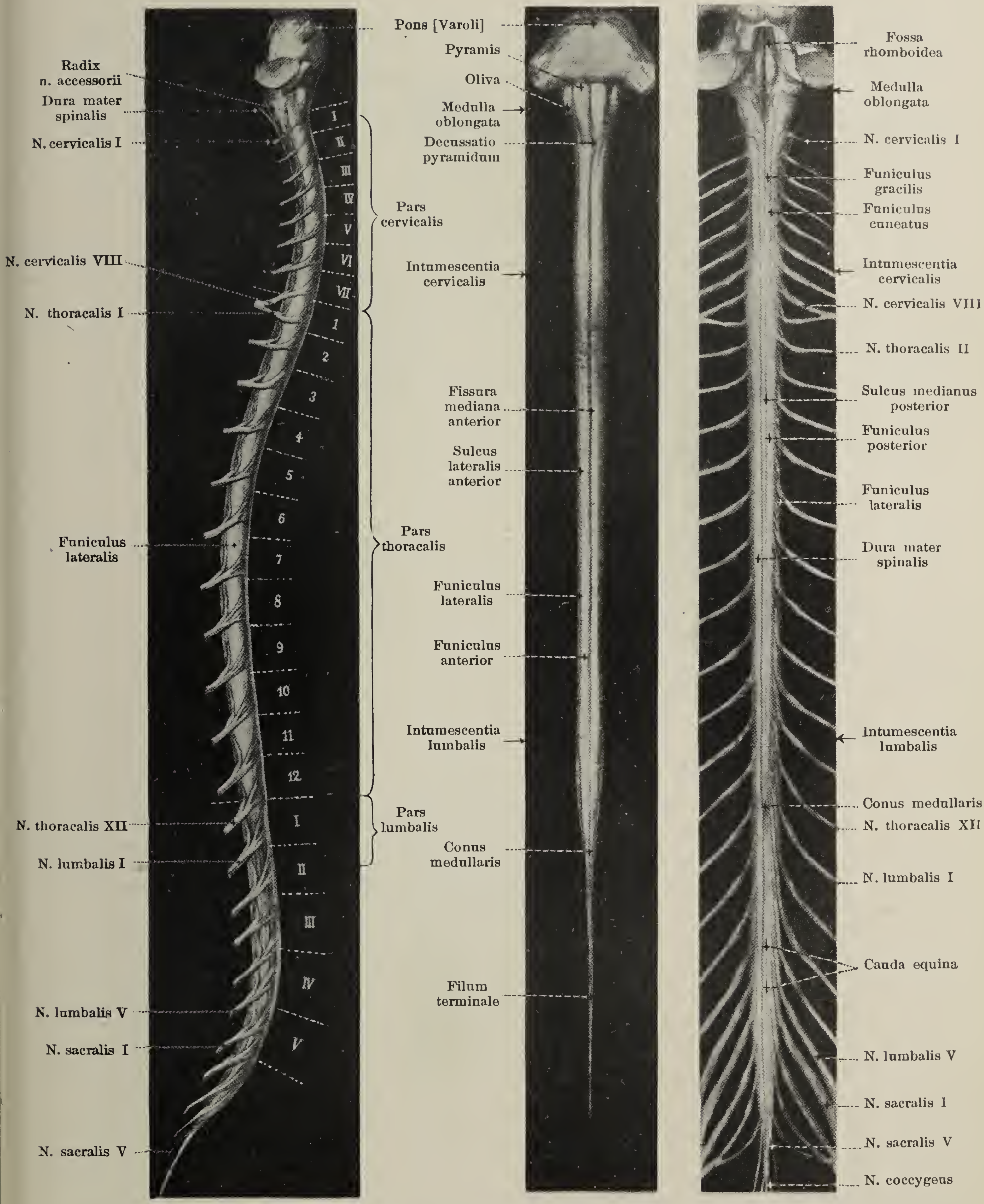
The **glands of the breast,** *corpus mammae,* enclosed by the breast, form a disk with rounded angles, the smooth posterior surface of which lies for the most part upon the m. pectoralis major, in a smaller lateral portion upon the m. serratus anterior; it is connected with these muscles by the loose connective tissue of the fascia pectoralis so as to be movable upon them. The anterior surface is very uneven and presents, especially below and lateralward, numerous comb-like and jagged processes which leave deep spaces between them. From the apices of these elevations go off connective tissue cords, *retinacula cutis,* to the cutis and all the interspaces between the gland substance; retinacula and cutis are filled up by masses of fat. The gland has 15—24 and more irregular *lobes, lobi mammae,* separated from one another by connective tissue; these lobes are broader peripheralward and have their apices directed toward the nipple. Each lobe is again subdivided by the penetrating connective tissue into numerous smaller *lobules, lobuli mammae,* and possesses one excretory duct, *ductus lactiferus,* which extends as a whitish cord in the yellowish-red glandular tissue to the apex of the lobe, and there bends around into the nipple. Before entrance into the nipple each excretory duct presents a spindle-shaped dilatation, *sinus lactiferus,* which may reach half a centimetre in width. In the nipple itself the ductus lactiferi run parallel to one another and open in the depressions at the apex.

In the region of the nipple and of the areola there are well developed sebaceous glands, *glandulae sebaceae.* In the areola sweat glands, *glandulae sudoriferae,* are found in small number as well as several rudimentary milk glands, *glandulae areolares [Montgomerii],* which latter open each with one small milk duct at the level of the elevation caused by it.

The skin over the breast is soft and delicate and is especially thin on the nipple and areola. Its color in the last two places is light red in nulliparae, while in beginning pregnancy it usually becomes dark brown.

The **male breast,** *mamma virilis* (not illustrated), is a small flat structure which consists essentially of connective tissue and usually contains indications of glandular tissue. It possesses a brown *areola mammae* and a *papilla mammae,* but the latter is smaller than in the female. The nipple lies usually in the 4th intercostal space, more rarely upon the 4th or 5th rib, the level frequently varying on the right and left sides; the nipples of the two sides may vary in distance from the median plane.

Supernumerary nipples and breasts, *mammae accessoriae (muliebres et viriles),* occur in very variable development in both sexes in the region of two lines which run down from the attachment of the upper extremities, converging over the normal glands, to the genitalia.

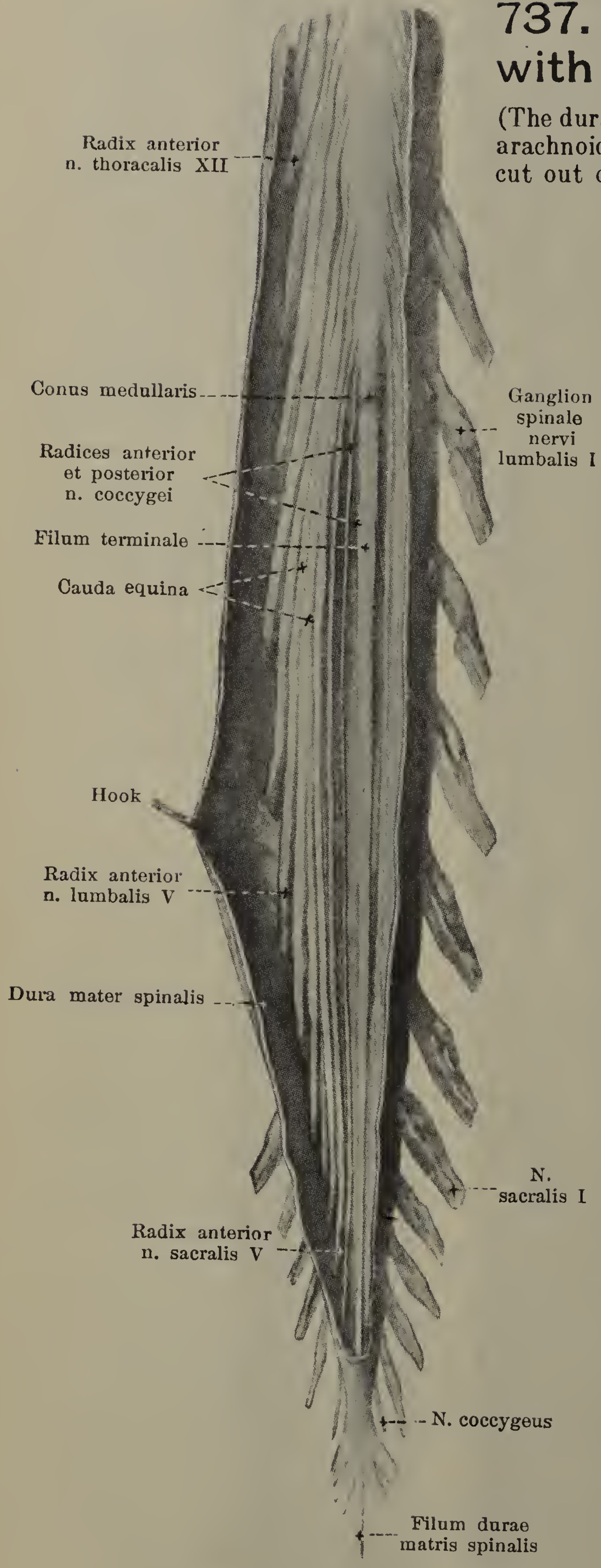


734—735. Spinal Cord.

Viewed from the right. Viewed from in front. (Nerve roots not shown.) Viewed from behind.

737. Lower end of spinal cord with nerve roots, viewed from in front.

(The dura mater has been opened and drawn to the right side; the arachnoidea has been removed. On the left side pieces have been cut out of the anterior roots of the 1st and 2nd lumbar nerves.)

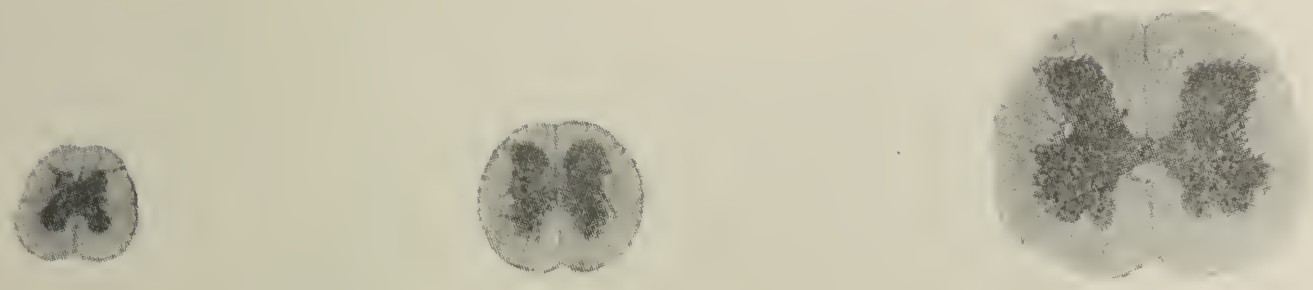

Radix anterior n. thoracalis XII
Conus medullaris
Radices anterior et posterior n. coccygei
Filum terminale
Cauda equina
Hook
Radix anterior n. lumbalis V
Dura mater spinalis
Radix anterior n. sacralis V
Ganglion spinale nervi lumbalis I
N. sacralis I
N. coccygeus
Filum durae matris spinalis

The **central nervous system** *(systema nervorum centrale)* is divisible into the *spinal cord (medulla spinalis)* and the *brain (encephalon).*

The **spinal cord** *(medulla spinalis)* (see also Figs. 734—736 and 749), an aproximately cylindrical cord more or less flattened from before backward, lies within the vertebral canal and presents curvatures corresponding to those of the canal. Above, it goes over insensibly, between the atlas and the occipital bone, into the medulla oblongata; below, it tapers into a short, wedge-like portion *(conus medullaris)* and, in the adult, goes over at the lower margin of the first, or opposite the upper part of the second, lumbar vertebra into a long, delicate *terminal thread (filum terminale)* which can be followed as far as the posterior surface of the coccyx.

The spinal cord is divisible into three parts: the *pars cervicalis* includes the region of exit of the cervical nerves, the *pars thoracalis* that of the thoracic nerves, the *pars lumbalis* that of the lumbar and sacral nerves. The diameters of the spinal cord are not the same at all levels; those portions of the cord which give off the nerves for the extremities are thickened especially in the frontal direction to form spindle-shaped enlargements. The *cervical enlargement (intumescentia cervicalis)* extends from the 3rd cervical to the 2nd thoracic vertebra, its greatest breadth corresponding to the 5th or 6th cervical vertebra; the *lumbar enlargement (intumescentia lumbalis)* begins at the 9th or 10th thoracic vertebra, is most marked at the 11th or 12th thoracic vertebra, and, at the 1st or 2nd lumbar vertebra, goes over into the conus medullaris.

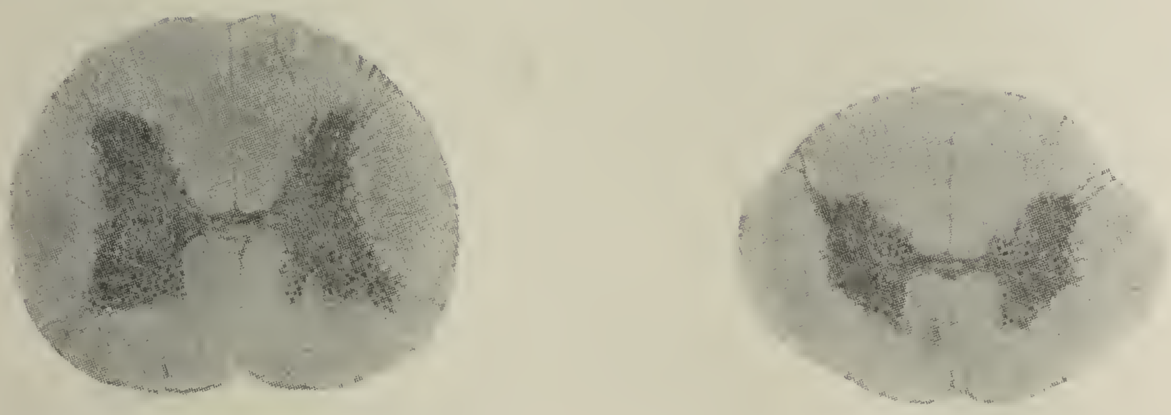
The ***surface of the spinal cord*** (see Figs. 734—736 and 738—747) is divided into two nearly symmetrical halves by a broad, deep anterior median fissure *(fissura mediana anterior)*, which contains a duplicature of the pia mater spinalis rich in blood vessels, and a median posterior sulcus *(sulcus medianus posterior)*, from which extends a median septum of neuroglia *(septum medianum posterius)* to the interior. On each of these two lateral halves, in the posterior part 2½—3½ mm lateral from the sulcus medianus posterior can be seen a groove, *sulcus lateralis posterior*, along which the posterior roots enter the spinal cord; the anterior root fibres leave the spinal cord on its anterior aspect along a zone about 2 mm broad, situated somewhat lateralward from the fissura mediana anterior, running nearly parallel to it, and called the *sulcus lateralis anterior*. In the cervical region there is still another delicate longitudinal groove on the posterior surface, the *sulcus intermedius posterior* (see Fig. 758); it runs downward from the medulla oblongata about 1 mm lateralward from the sulcus medianus posterior and corresponds to the junction of the fasciculus gracilis with the fasciculus cuneatus. Occasionally an analogous groove, *sulcus intermedius anterior* (not illustrated), can be seen sometimes on the anterior surface of the cervical portion, forming the lateral boundary of the fasciculus cerebrospinalis anterior.



Level of exit of 5th sacral nerve

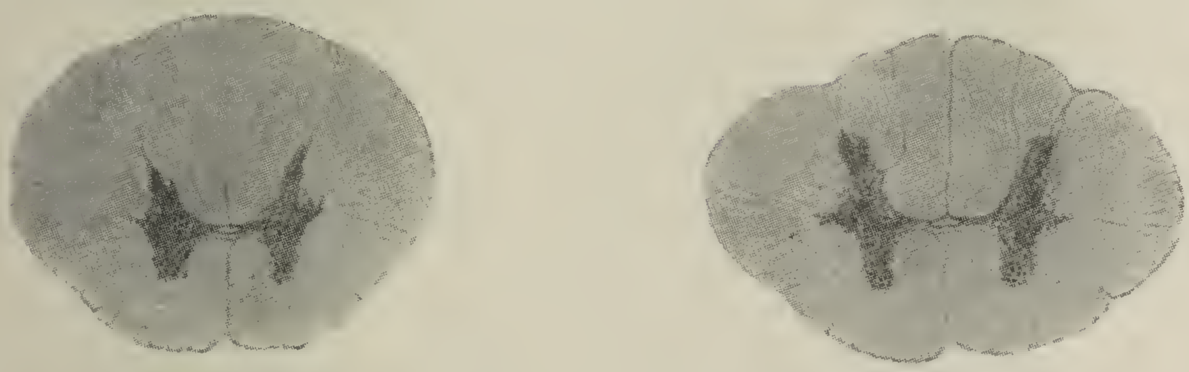
Level of exit of 3rd sacral nerve

Level of exit of 1st sacral nerve



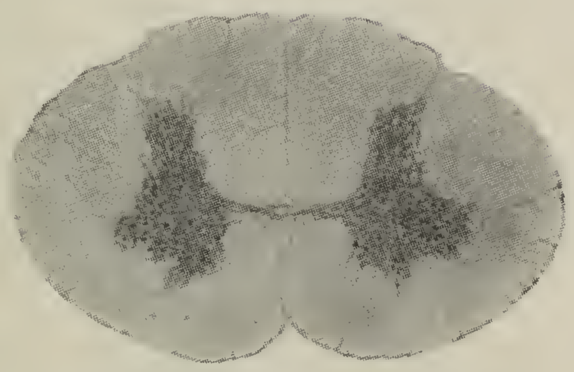
Level of exit of 3rd lumbar nerve (maximal breadth of lumbar enlargement)

Level of exit of 1st lumbar nerve



Level of exit of 8th thoracic nerve

Level of exit of 2nd thoracic nerve



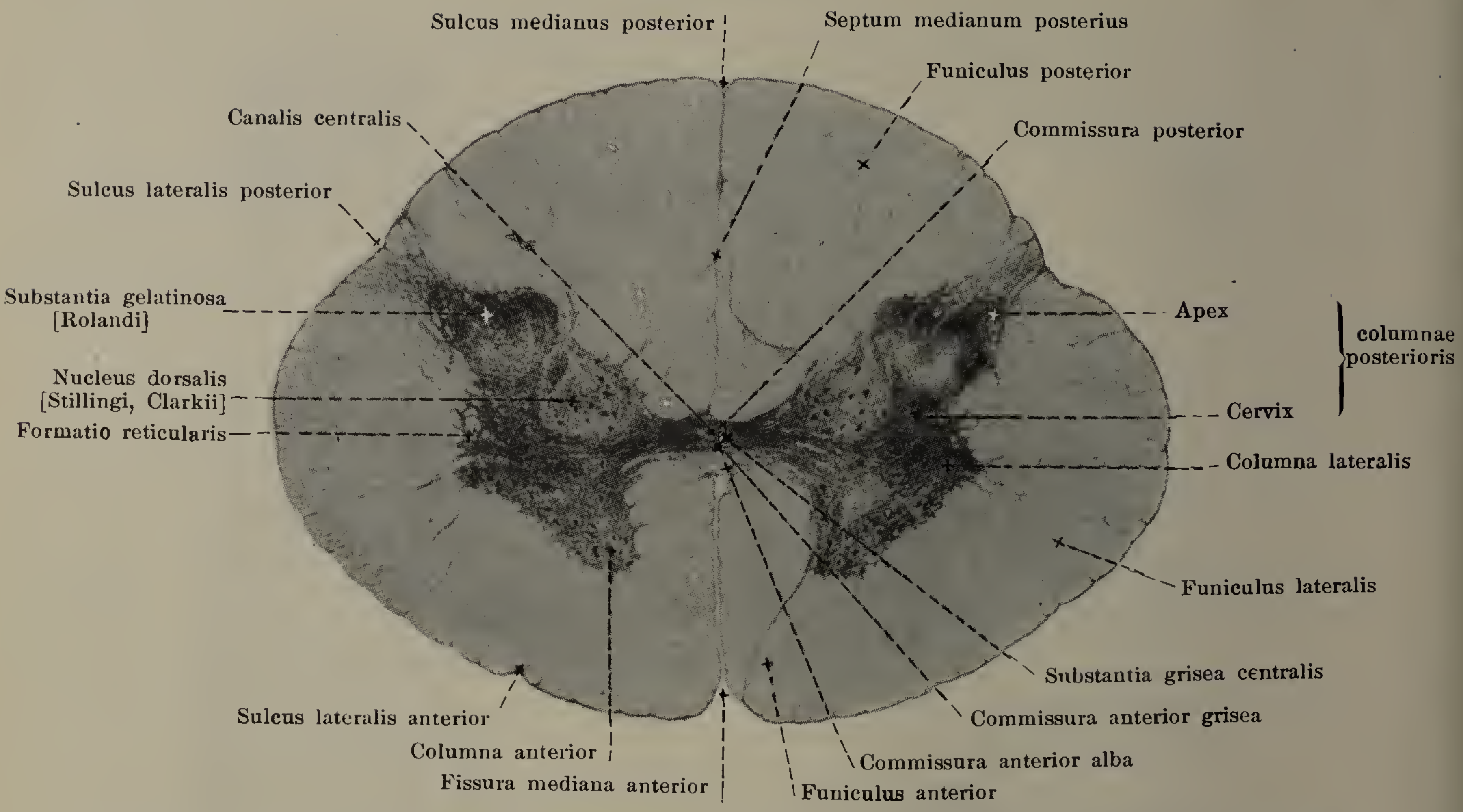
Level of exit of 5th cervical nerve (maximal breadth of cervical enlargement)

738. Transverse sections through the adult spinal cord.

Magnification: 4:1. (Held.)

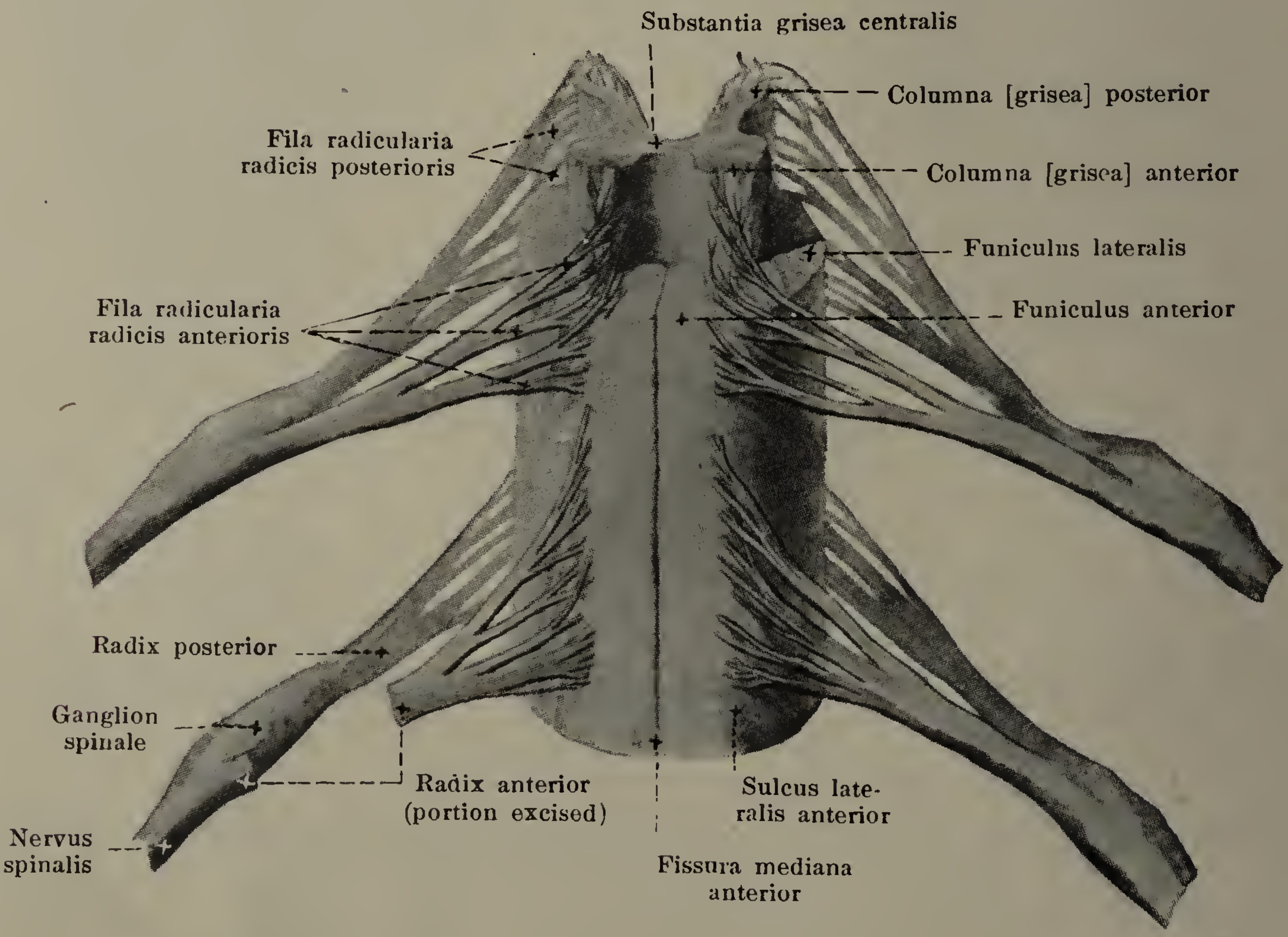
(The sections have all been taken from the same spinal cord and are so arranged that the dorsal margin of the section is uppermost.)

Surface of the spinal cord (continued) (see Figs. 734—736, 739, 740 and 802). The prismatic mass situated on each side between the fissura mediana anterior and the lateral bundles of the anterior root fibres is called the *anterior funiculus (funiculus anterior,* O. T. anterior column): the mass which extends from this to the sulcus lateralis posterior is called the *lateral funiculus (funiculus lateralis)* and that between the sulcus lateralis posterior and the sulcus medianus posterior, the *posterior funiculus (funiculus posterior).*



739. Transverse section through the uppermost part of the lumbar cord of an adult. Magnific.: 10:1. (Held.)

(The section is the same as the fifth one in Fig. 738.)


Substantia grisea centralis
Columna [grisea] posterior
Fila radicularia radicis posterioris
Columna [grisea] anterior
Funiculus lateralis
Fila radicularia radicis anterioris
Funiculus anterior
Radix posterior
Ganglion spinale
Radix anterior (portion excised)
Sulcus lateralis anterior
Nervus spinalis
Fissura mediana anterior

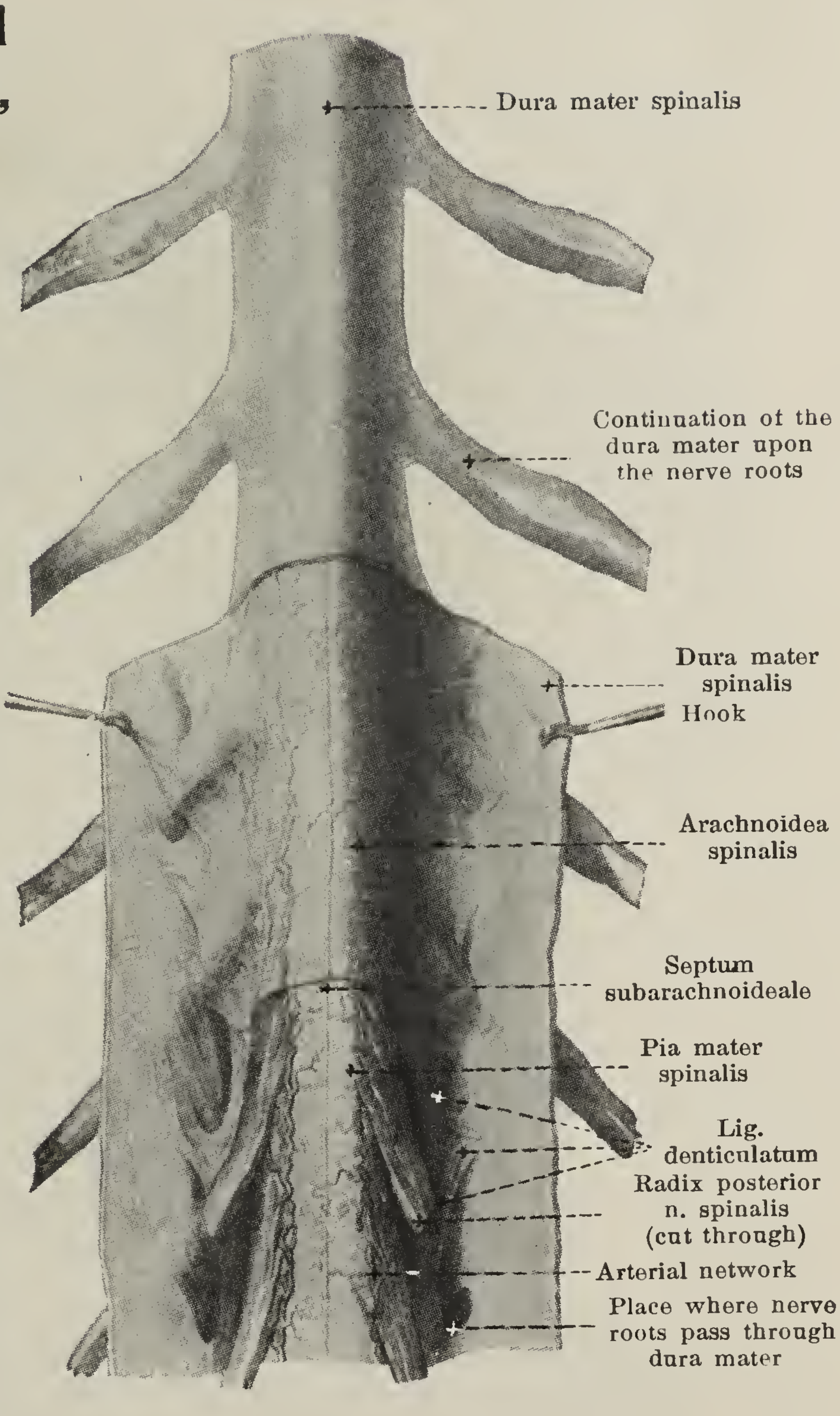
740. Portion of the spinal cord with the roots of two nerves, viewed from in front, partly schematic. Magnific.: ca. 3:1.

(In the uppermost part the white matter has been removed.)

741. Portion of spinal cord with membranes,

viewed from behind.

(The dura mater has been slit up below and turned aside; the arachnoidea has been in part removed.)


Dura mater spinalis
Continuation of the dura mater upon the nerve roots
Dura mater spinalis
Hook
Arachnoidea spinalis
Septum subarachnoideale
Pia mater spinalis
Lig. denticulatum
Radix posterior n. spinalis (cut through)
Arterial network
Place where nerve roots pass through dura mater

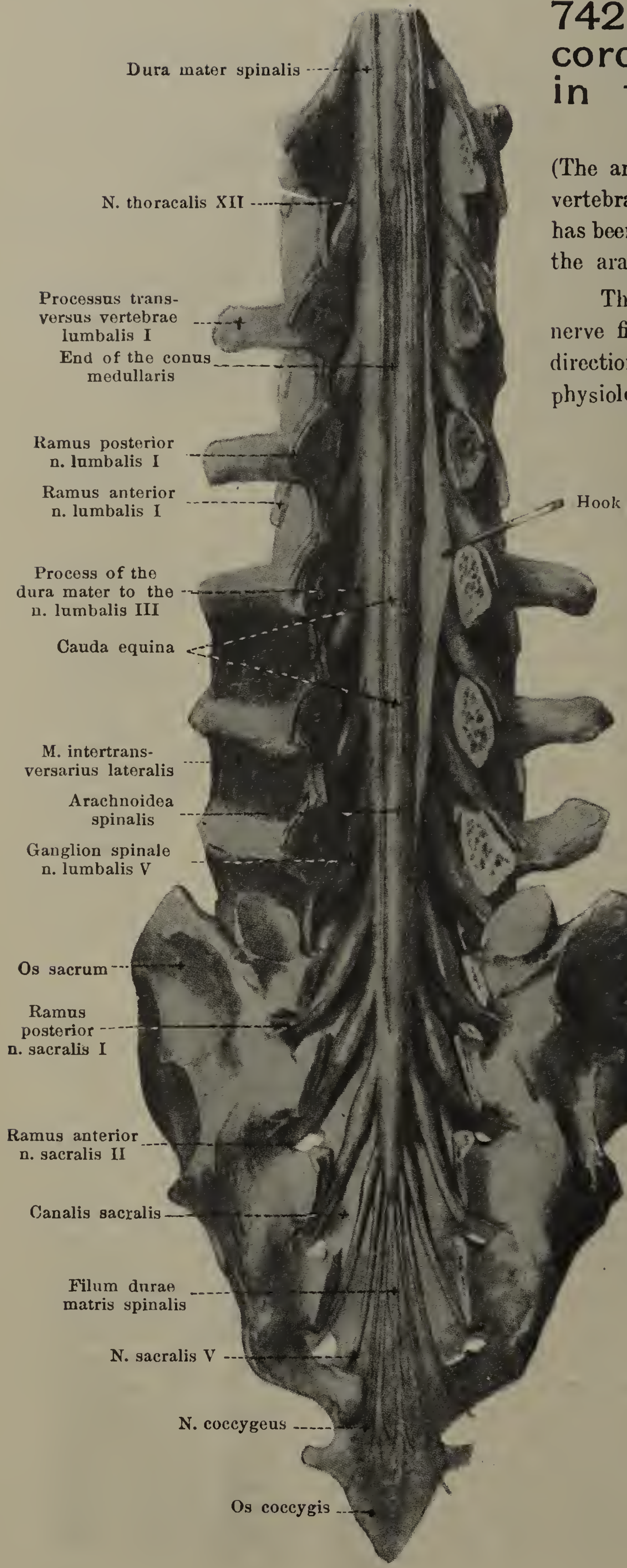
The ***interior of the spinal cord*** (see Figs. 738—740 and 802—804) consists of *gray matter (substantia grisea)* and *white matter (substantia alba)*, the reciprocal volume-relations of which vary somewhat at different levels (see Fig. 738).

The *gray matter* contains the nerve cells and lies in the interior of the spinal cord, so that it nowhere touches the surface; it consists of two markedly developed lateral parts, one on each side of the cord, and of a bridge connecting the two in the middle so that on cross section an H-like figure is produced. The bridge in the middle usually lies somewhat nearer the anterior surface of the cord than the posterior and surrounds the small rounded or oval *central canal (canalis centralis)*. This canal is continued above into the medulla oblongata and opens at the inferior angle of the rhomboid fossa, in front of the obex (see p. 649), into the fourth ventricle; in the lower part of the conus medullaris it becomes widened to form the elongated, usually three-sided *ventriculus terminalis* (not illustrated) and then runs as an extremely fine canal for a variable distance far into the filum terminale, finally ending blind; it contains a small amount of fluid and is immediately surrounded by the *substantia grisea centralis*. In the adult it is frequently obliterated at intervals. The transverse gray bar behind it is called the *commissura posterior*, the very narrow band in front of it the *commissura anterior grisea*, the latter being immediately adjacent to the *commissura anterior alba* which belongs to the white matter. In the lateral parts of the gray matter, the form of which varies somewhat at different levels, two approximately cylindrical *columnae griseae* can be distinguished on each side. The *columna anterior (anterior column, anterior horn)* is directed forward and a little lateralward and reaches backward as far as the gray bridge mentioned. The *columna posterior (posterior column, posterior horn)* extends from here backward and a little lateralward in places going very close to the surface; it is longer and narrower than the columna anterior, is constricted somewhat ventralward *(cervix columnae posterioris)* and is somewhat pointed dorsalward *(apex columnae posterioris)*; the sickle-shaped area seen in cross section, bounding the posterior horn behind, is called the *substantia gelatinosa [Rolandi]*. The sharply circumscribed group of ganglion cells situated on the medial side of the posterior horn, near the commissura posterior, extending from the 2nd lumbar to the 7th cervical nerve, and most markedly developed in the upper lumbar and lower thoracic cord, is called the *nucleus dorsalis [Stillingi, Clarkii] (Clarke's column)*; it is round or oval in cross section. In the upper part of the thoracic cord, projecting lateralward from the posterior part of the anterior horn into the white substance, is a triangular process, *columna lateralis (lateral column, lateral horn)*; it gradually vanishes below; in the cervical cord it fuses with the anterior horn to form a common mass. In the angle between it and the posterior horn, the gray matter sends strands out lateralward, arranged in the form of a network, *formatio reticularis*; these are indistinct in the lumbar cord but become progressively more marked toward the upper end of the spinal cord.

742. Lower end of spinal cord with membranes in the vertebral canal,

viewed from behind.

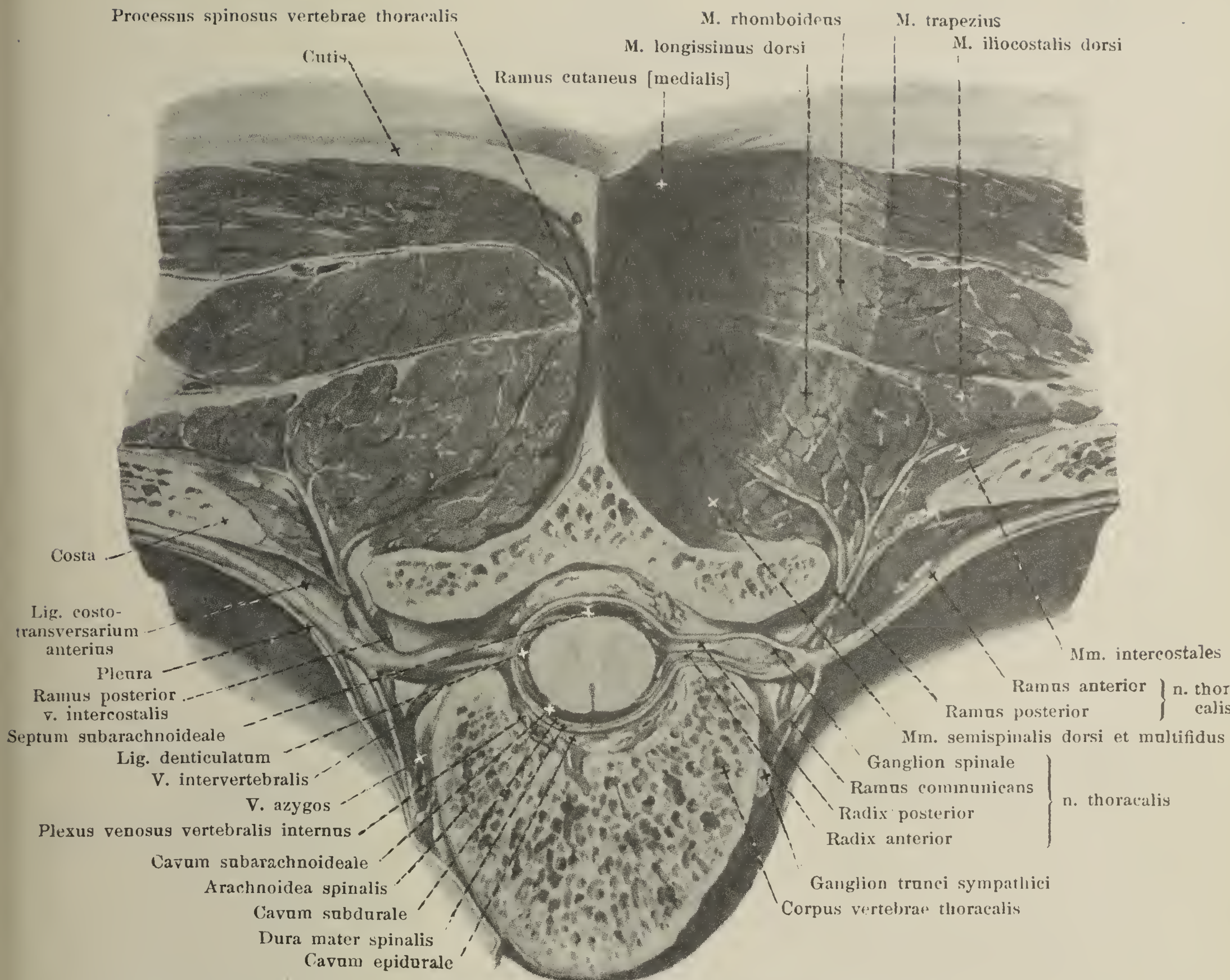
(The arches of the thoracic, lumbar and sacral vertebrae have been removed; the dura mater has been slit open lengthwise and partly reflected; the arachnoidea has been in large part removed.)


Dura mater spinalis
N. thoracalis XII
Processus transversus vertebrae lumbalis I
End of the conus medullaris
Ramus posterior n. lumbalis I
Ramus anterior n. lumbalis I
Hook
Process of the dura mater to the n. lumbalis III
Cauda equina
M. intertransversarius lateralis
Arachnoidea spinalis
Ganglion spinale n. lumbalis V
Os sacrum
Ramus posterior n. sacralis I
Ramus anterior n. sacralis II
Canalis sacralis
Filum durae matris spinalis
N. sacralis V
N. coccygeus
Os coccygis

The *white matter* contains only medullated nerve fibres; they run chiefly in a longitudinal direction and are divisible into a number of physiologically non-equivalent bundles, the size of which varies at different levels and the areas of which partly overlap. Concerning these bundles and the principal groups of cells of the gray matter and their connections, the reader is referred to Figs. 802—804.

In the conus medullaris the white matter is relatively much reduced as compared with the gray; the latter has gradually fused to a common mass in which the differentiation of anterior horn and posterior horn is impossible. In the filum terminale the gray and the white matter are continued in the same arrangement for 6—8 cm further. Further down, the filum terminale consists of connective tissue, vessels and the rudiments of the 2nd and 3rd nervus coccygeus, which then extend caudally.

The spinal cord is surrounded by the ***membranes of the cord*** (see also Figs. 737, 741 and 743), which are continuous above with the *membranes of the brain*, forming with these the *meninges*. The ***pia mater spinalis (soft membrane of the cord)*** is everywhere closely attached to the spinal cords as a delicate vascular membrane. It sends a duplicature into the fissura mediana anterior and with the blood vessels numerous fine processes into the substance of the spinal cord. Below, it surrounds the portion of the filum terminale situated in the sac of the dura mater and then fusses with the dura mater.

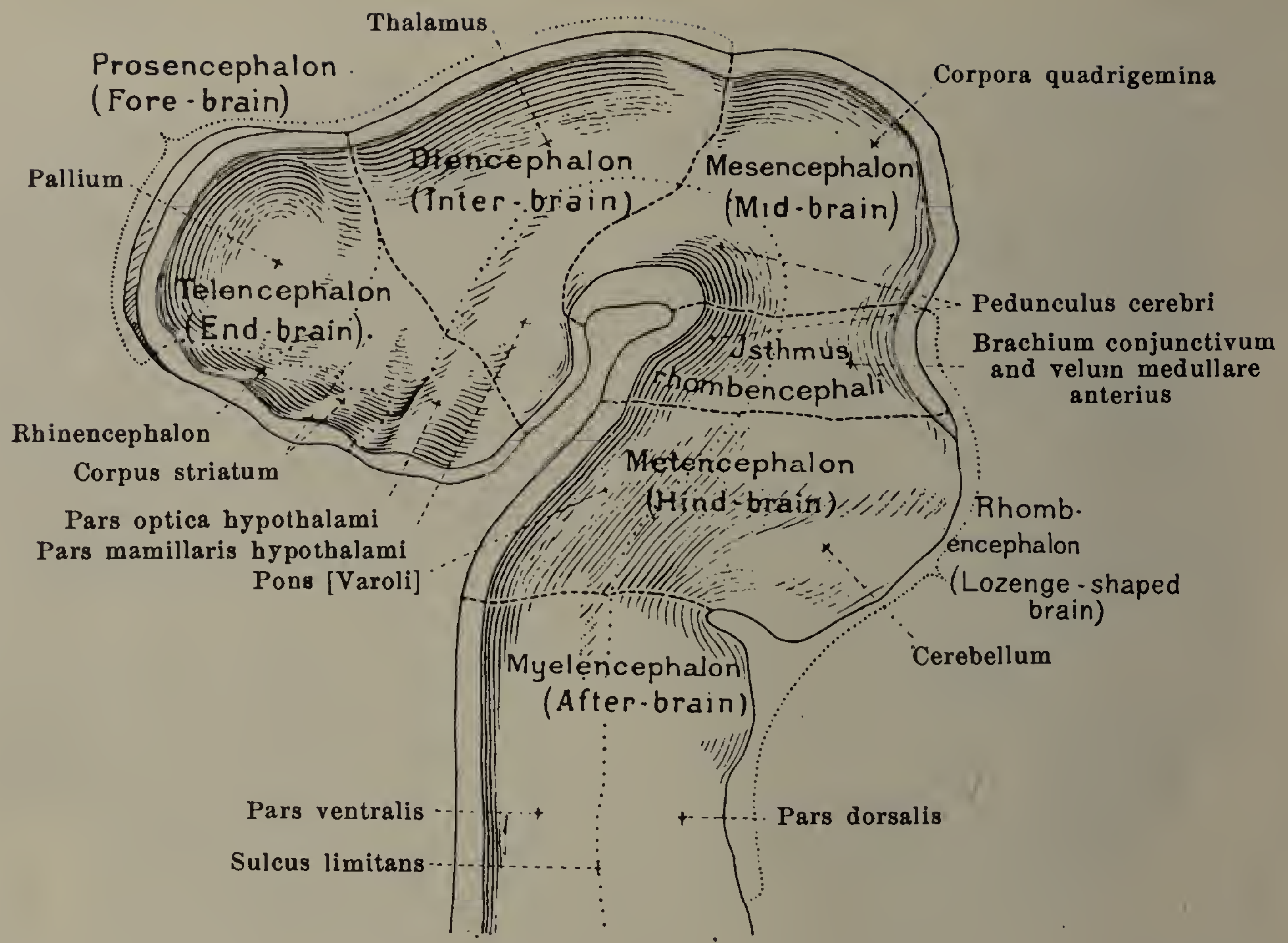


743. Cross-section of the spine with its muscles.

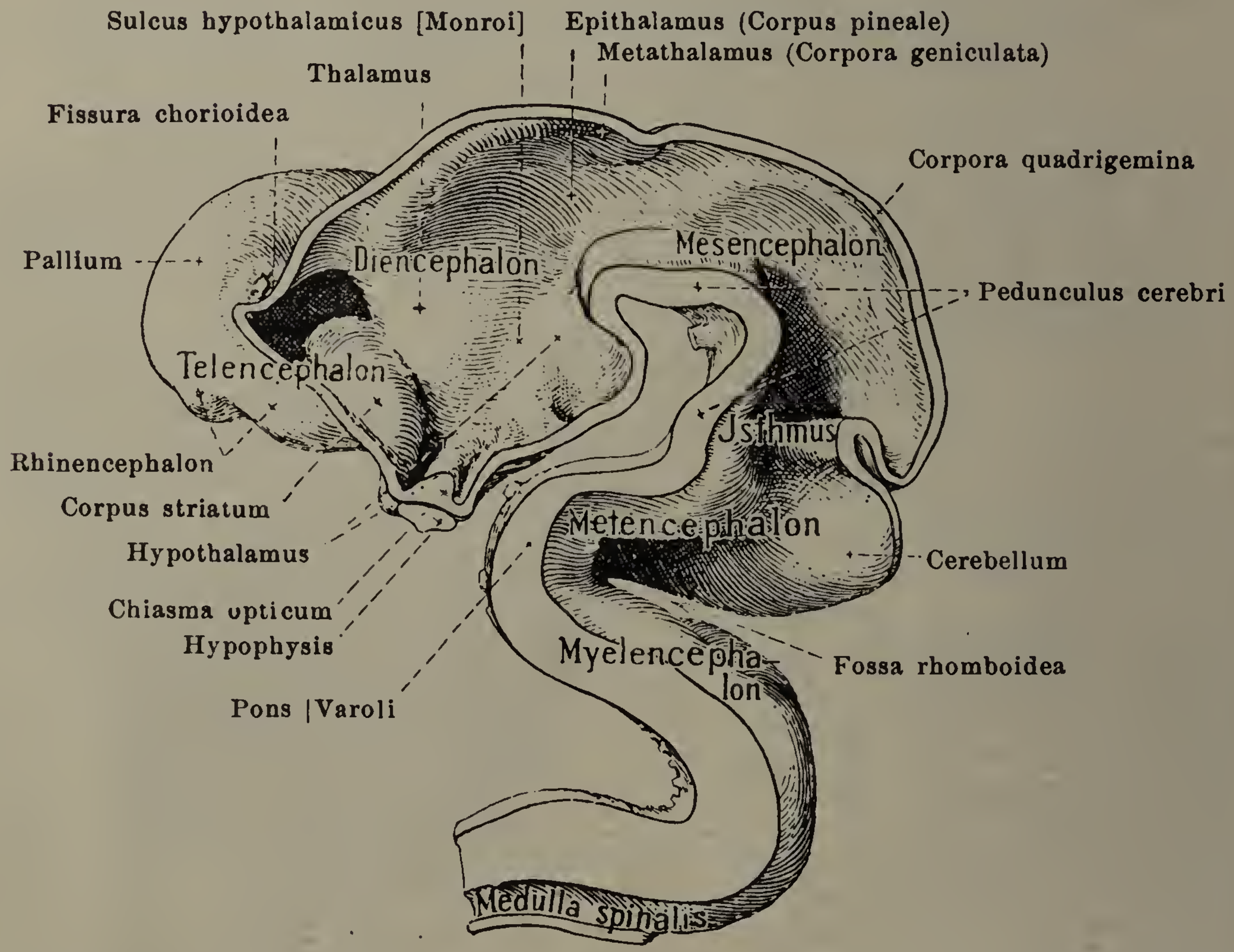
(On the left side the pleura has been drawn aside and a piece of muscle has been cut out.)

Membranes of the spinal cord (continued) (see also Figs. 737, 741 and 742). Going off from the lateral surface of the pia mater spinalis on each side is a frontally placed leaflet of connective tissue, *ligamentum denticulatum,* which runs between the anterior and posterior nerve roots and becomes attached to the inner surface of the dura mater usually by twenty-one jags; the jags are inserted there usually between the points of exit of two nerves, the uppermost one a little above the place where the a. vertebralis passes through the dura mater (see Fig. 833), the lowermost one between the last thoracic and the first lumbar nerve. The *arachnoidea spinalis (cobweb membrane),* a very delicate non-vascular membrane, forms a sac which surrounds the spinal cord only loosely; it is separated from the dura mater merely by a capillary slit, *cavum subdurale,* from the pia mater by a large space, *cavum subarachnoideale,* filled with *liquor cerebrospinalis.* The arachnoidea ensheaths the lig. denticulatum and, especially along the sulcus medianus posterior, sends fine threads to the pia; in the lower cervical region and in the thoracic region these fuse to form lamellae, *septum subarachnoideale.* The *dura mater spinalis (hard membrane of the cord)* is a tough connective tissue tube, poor in blood vessels, which, tapering out, ends blind (with the arachnoidea) below the conus medullaris at the level of the 2nd or 3rd sacral vertebra; from there on it forms a direct covering for the filum terminale known as the *filum durae matris spinalis.* It is separated from the periosteum of the vertebral canal by fat, connective tissue and venous plexuses (see p. 472), among which there exists a system of lymph spaces, *cavum epidurale,* reaching above as for as the foramen occipitale magnum, below as for as the hiatus sacralis; strong bands of connective tissue pass from its anterior surface to the lig. longitudinale posterius, especially in the canalis sacralis.

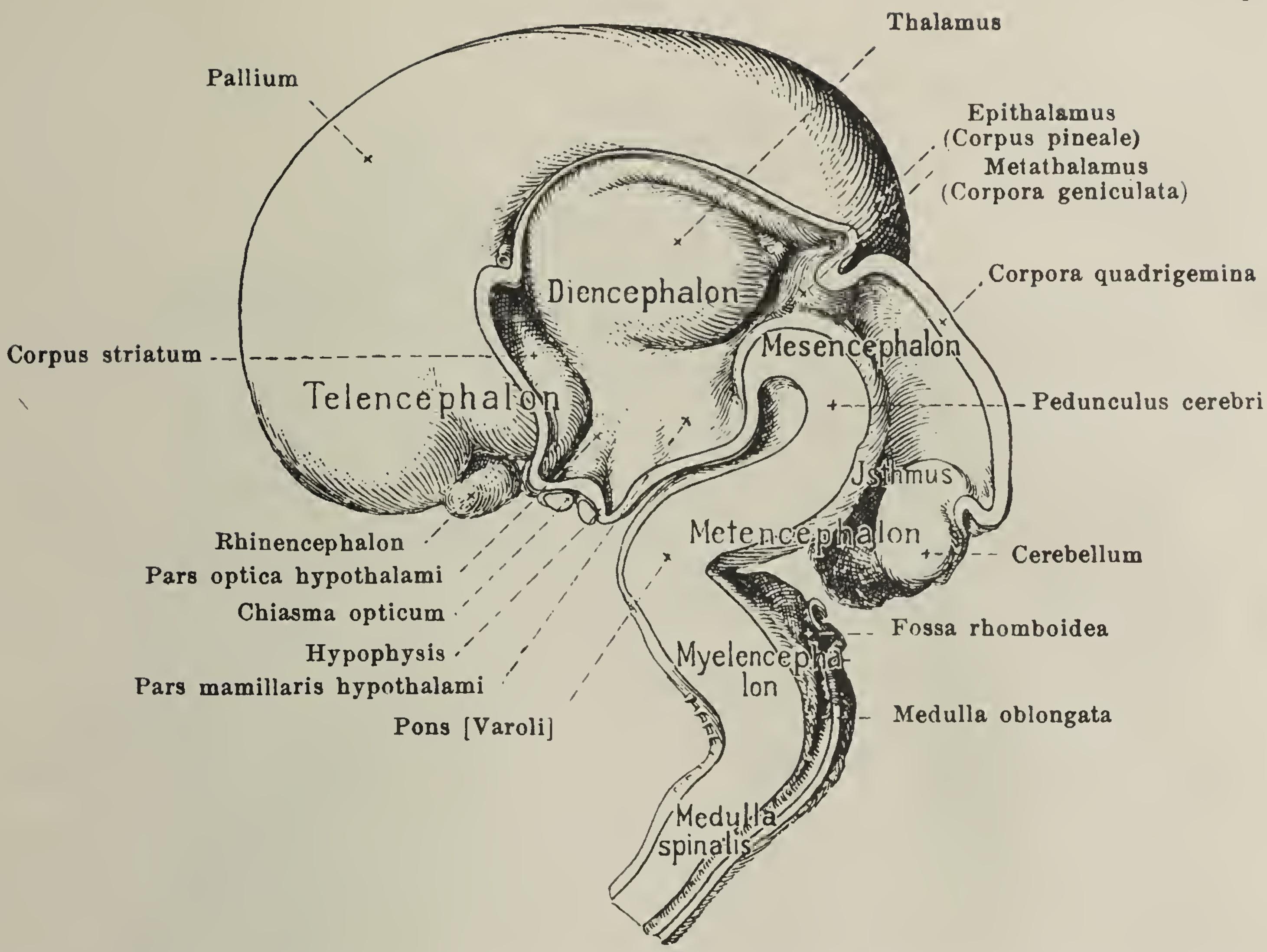
All three membranes are continued upon the nerve roots, fuse near the ganglia, and then go over into the connective tissue sheaths of the nerves.



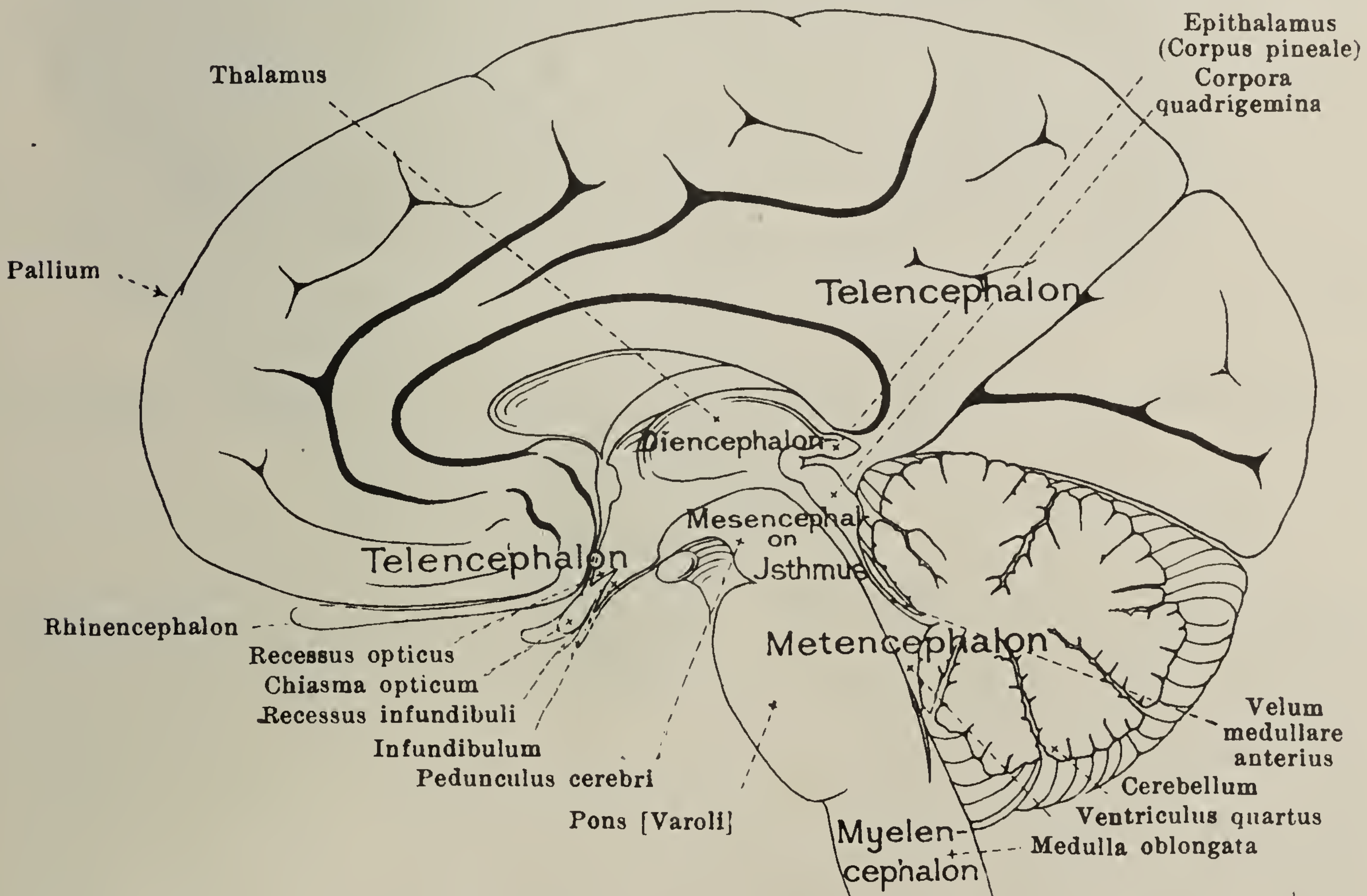
744. Brain of a human embryo at end of 1st month,
right half, viewed from the left. (After a model by W. His.)



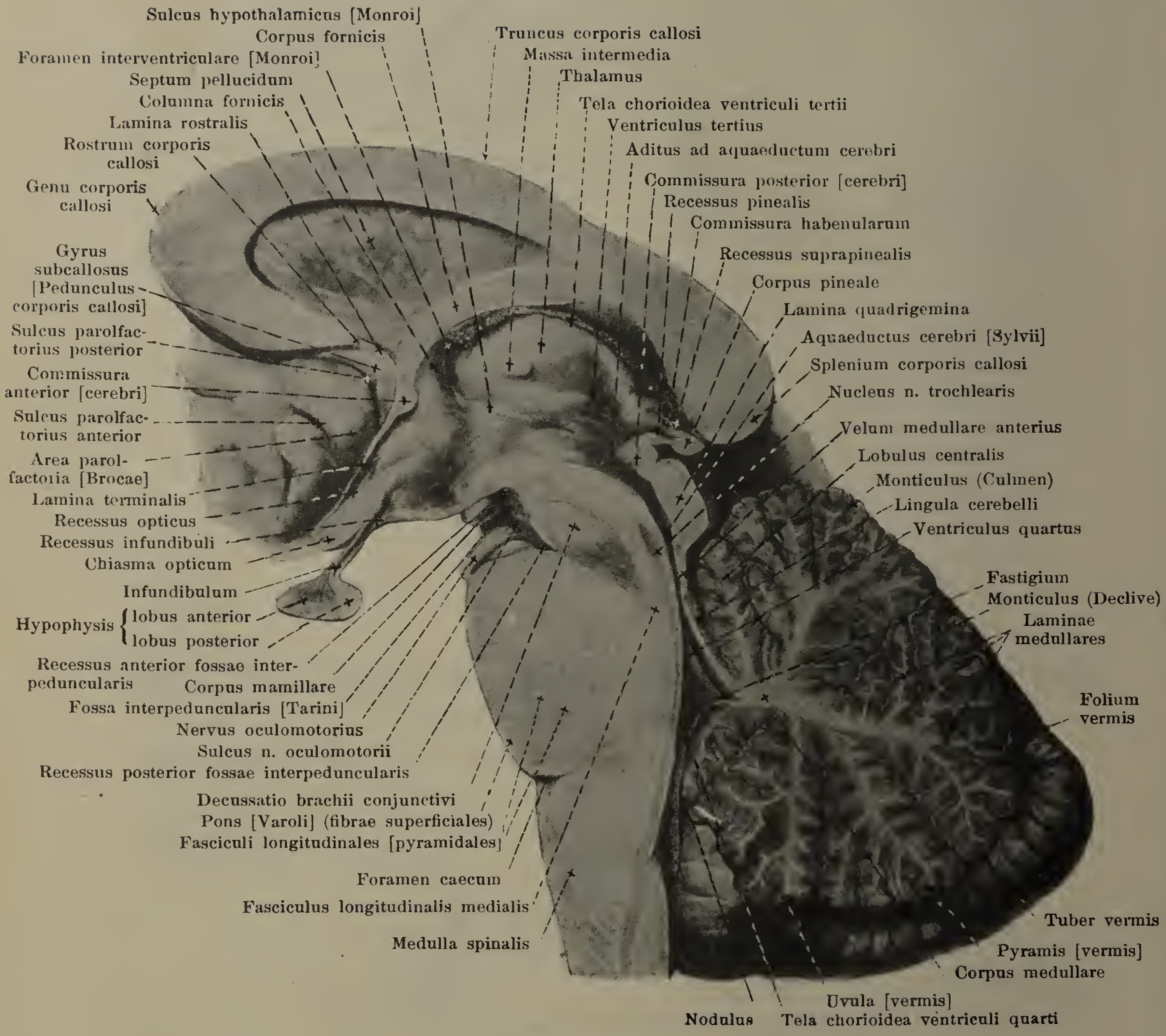
745. Brain of a human embryo five weeks old,
right half, viewed from the left. (After a model by W. His.)



746. Brain of a human embryo in the third month,
right half, viewed from the left.
(After a model by W. His; cerebral hemisphere after F. Hochstetter.)



747. Adult human brain,
right half, viewed from the left, partly schematic.

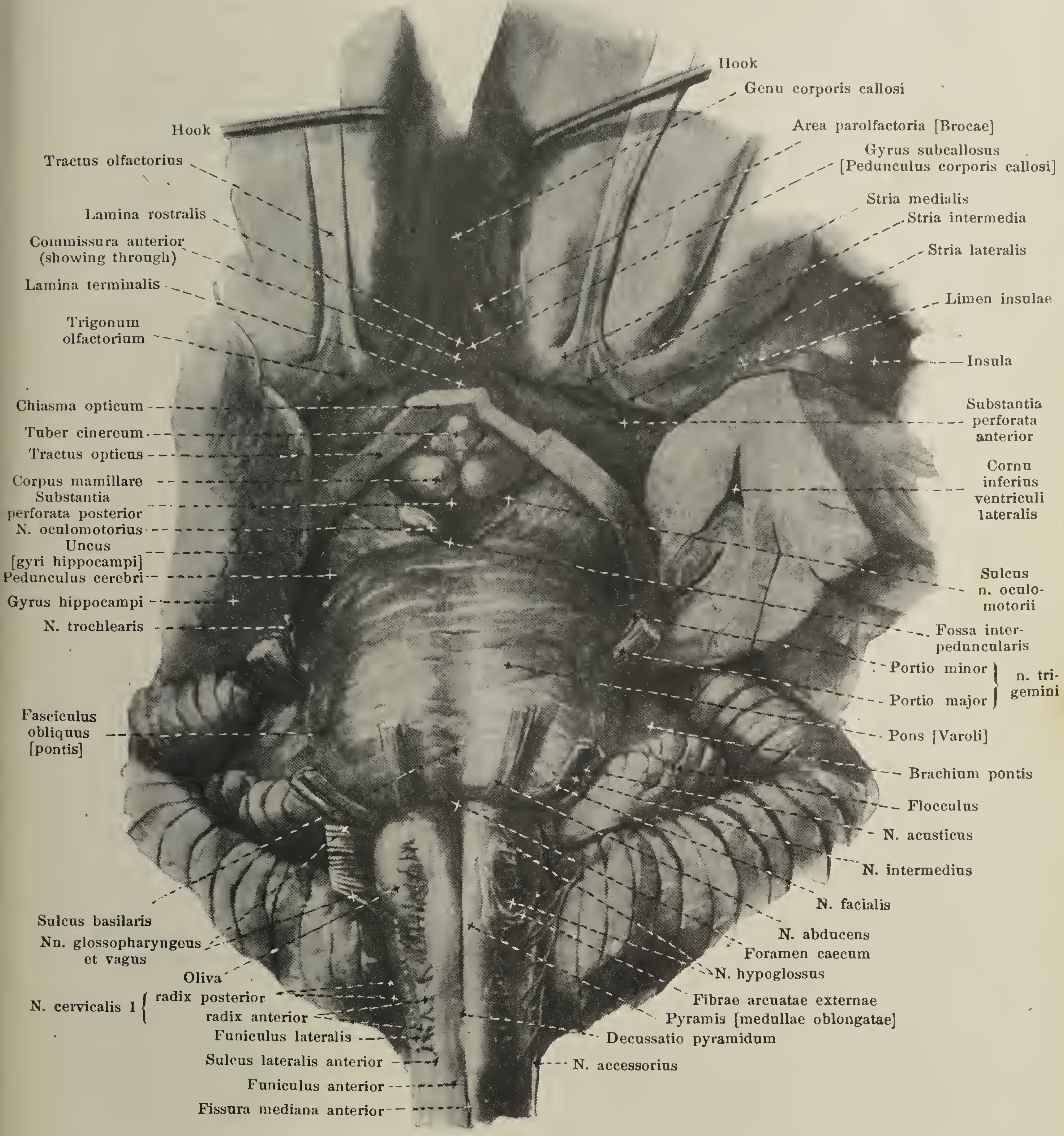


748. Median section through the brain-stem,
right half, viewed from the left.

(Only a very small part of the brain mantle is shown.)

The **brain** *(encephalon)* (see Figs. 744—747) is divisible on embryological grounds into *rhombencephalon (lozenge - shaped brain)*, *mesencephalon (mid-brain)*, and *prosencephalon (fore-brain)*; the two latter together form the *cerebrum (large brain)*. In the *rhombencephalon* are included the *myelencephalon (after-brain)*, which corresponds to the medulla oblongata, the *metencephalon (hind-brain)*, which includes the pons and the cerebellum, and the *isthmus rhombencephali*, that narrow portion of the brain surrounding the upper end of the rhomboid fossa to which parts of the pedunculi cerebri, the brachia conjunctiva and the velum medullare anterius belong. The *mesencephalon* includes parts of the pedunculi cerebri and the corpora quadrigemina. The *prosencephalon* is divisible into the *diencephalon (inter-brain)* to which belong the *pars mamillaris hypothalami* and the *thalamencephalon* (= thalamus + metathalamus + epithalamus) and the *telencephalon (end-brain)* which includes the *pars optica hypothalami* and the *hemisphaerium* (= corpus striatum + rhinencephalon + pallium).

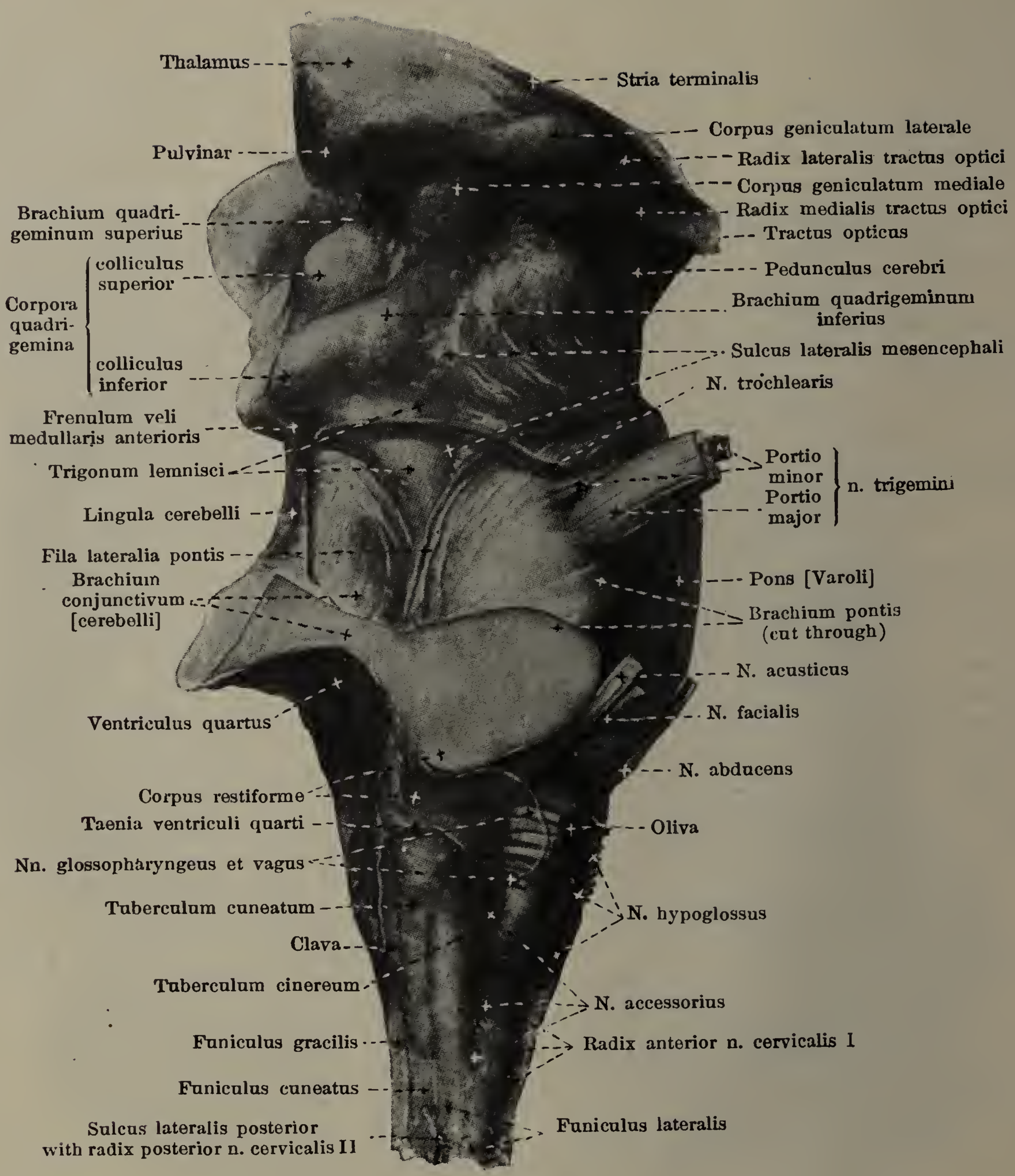
The term *brain-stem* is applied often to the part of the brain left after removal of the pallium.



749. Base of brain, viewed from below.

Magnification: circa 4 : 3.

(The cerebellar and cerebral hemispheres are shown only in part. The frontal lobes have been pulled apart. The anterior and medial portion of the left temporal lobe have been cut away and a piece has been excised from the left tractus opticus. On the right the radicular threads of the n. oculomotorius have been cut off short.)



750. Brain-stem, viewed from the right. Magnification: ca. 3 : 2.
(The cerebellum has been removed by cutting through the brachia pontis and the brachia conjunctiva; the cerebral hemispheres have also been removed.)

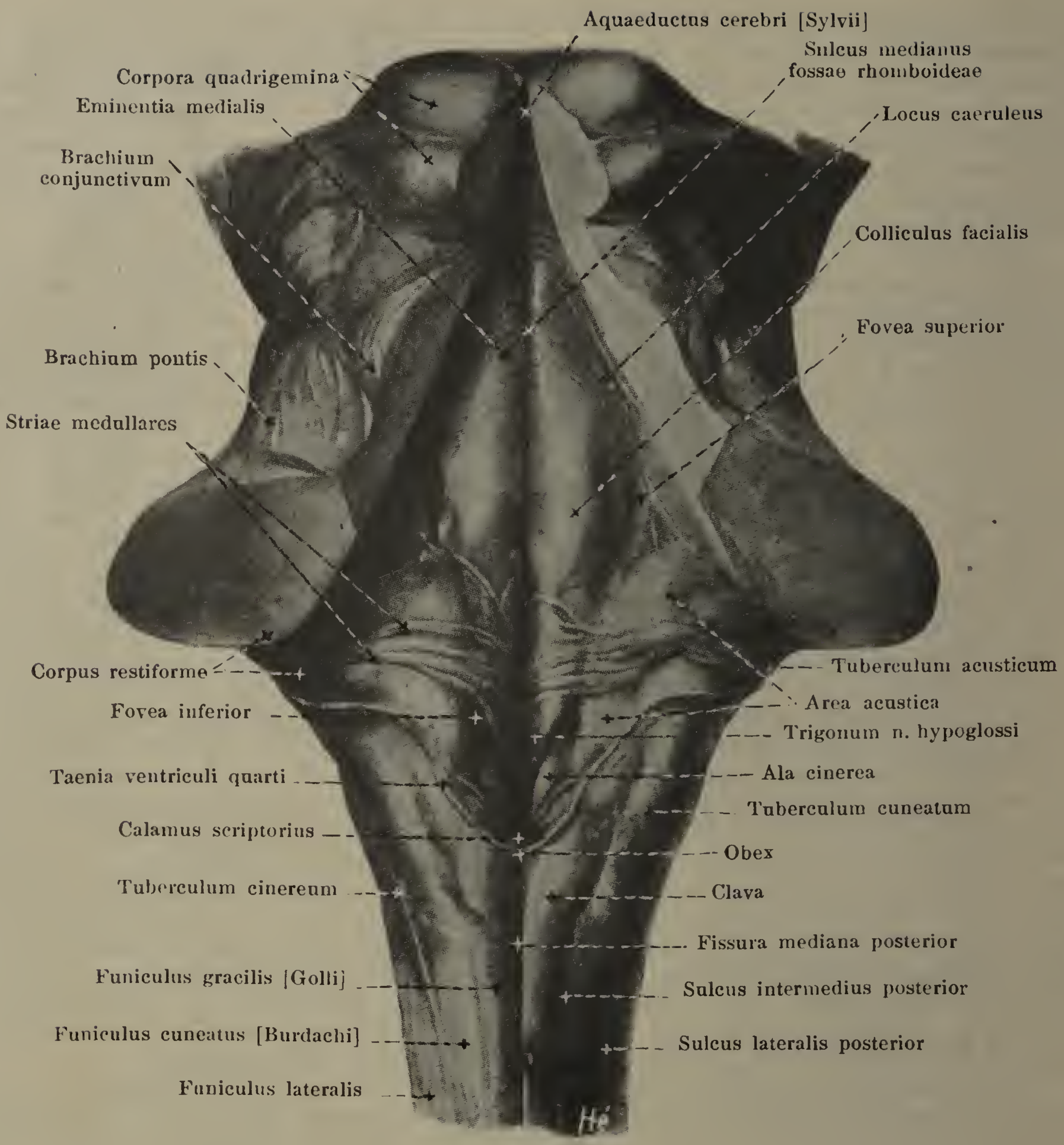
The **medulla oblongata** (see also Figs. 748, 749, 751, 752, 755 and 758) corresponds to the myelencephalon (see p. 646), is continuous without sharp limit with the upper end of the spinal cord; it lies for the most part in the skull and in an almost vertical direction. It extends from the upper root-bundles of the 1st cervical nerve as far as the inferior margin of the pons in front, and as far as the inferior margin of the pars intermedia of the 4th ventricle behind (see p. 649); it becomes expanded above, especially in the frontal direction, somewhat less so in the sagittal direction.

On its anterior surface (see Fig. 749), running in the median plane, is the deep *fissura mediana anterior;* it corresponds to the fissure of the same name in the spinal cord, but is separated from it, about at the level of the root-bundles of the 1st cervical nerve, by decussating bundles of nerve fibres, *decussatio pyramidum (decussation of the pyramids);* it ends above at the pons in a triangular depression, the *foramen caecum* (see also Fig. 748). The mass lying on each side of this fissure, the *pyramis [medullae oblongatae] (pyramid).* appears to be continuous with the anterior funiculus of the spinal cord, but in reality it sends only a small part of its fibre bundles into it to the „anterior pyramidal tract“, while the larger portion of them go to the lateral funiculus of the opposite side to form the „lateral pyramidal tract“ (see p. 686).

The pyramid is bounded lateralward by the *sulcus lateralis anterior*, which is a continuation of the sulcus of the same name in the spinal cord; from it emerge the root bundles of the n. hypoglossus. Lateral from this groove in the upper part of the medulla oblongata lies an oblong, egg-shaped elevation, the *oliva (olive);* it is somewhat broadened and thickened above and extends with a blunt pole as far as the pons; its surface is sometimes smooth, sometimes nodular; below, it is frequently crossed by arch-like fibres, *fibrae arcuatae externae*, which go from the surface of the corpus restiforme (vide infra) to the region of the sulcus lateralis anterior, sometimes overlying and obscuring the sulci (see also p. 687).

On the posterior surface (see Figs. 750 and 751) the *fissura mediana posterior* forms the continuation of the sulcus medianus posterior as far as the lower end of the rhomboid fossa (vide infra). The *sulcus lateralis posterior* and *sulcus intermedius posterior* run, as continuations of the sulci of the same names in the spinal cord, upward and somewhat lateralward; the former is frequently indistinct and extends upward as far as the level of the middle of the olive (see Fig. 750), the latter ends at the lower margin of the recessus lateralis fossae rhomboideae. The two *funiculi graciles [Golli]*, ascending from the spinal cord, broaden somewhat a little below the rhomboid fossa and present there a flattened bulging, the *clava;* from this swelling on, the funiculi graciles run along the lower lateral margin of the rhomboid fossa, diverging upward and lateralward; they gradually become narrowed and go over without sharp limit into the medial part of the corpora restiformia (vide infra). The *funiculus cuneatus [Burdachi]* is the continuation of the funiculus of the same name in the spinal cord and above is often bounded very indistinctly lateralward by the sulcus lateralis posterior; the funiculi of the two sides diverge from the clava on, passing upward and lateralward where each presents a variably developed slight projection, the *tuberculum cuneatum;* they become lost above on each side in the corpus restiforme (vide infra). The *funiculus lateralis* (see Fig. 750) is the direct prolongation of the funiculus of the same name in the spinal cord; it becomes somewhat broadened as it passes upward and extends in front as far as the lower end of the olive and behind it almost as far as its upper end. A fine groove in which the root-threads of the nn. accessorius, vagus and glossopharyngeus are situated, runs upward on the lateral funiculus from the upper end of the spinal cord; it is curved slightly forward and, passing somewhat behind the olive, extends almost as far as the pons; below, it separates a broader, anterior area from a narrower, posterior area; above, on the contrary, the posterior area is broader and presents, especially in the child, a distinct club-shaped swelling, *tuberculum cinereum* (see also p. 687), which reaches as far as behind the olive and finally goes over into the corpus restiforme. The name *corpus restiforme (rope-like body)* has been given, on account of its external appearance, to the bundle which is the apparent continuation of the funiculi gracilis and cuneatus and of the dorsal portion of the funiculus lateralis just mentioned, passes upward just in front of the recessus lateralis of the rhomboid fossa and bends around dorsalward to the cerebellum.

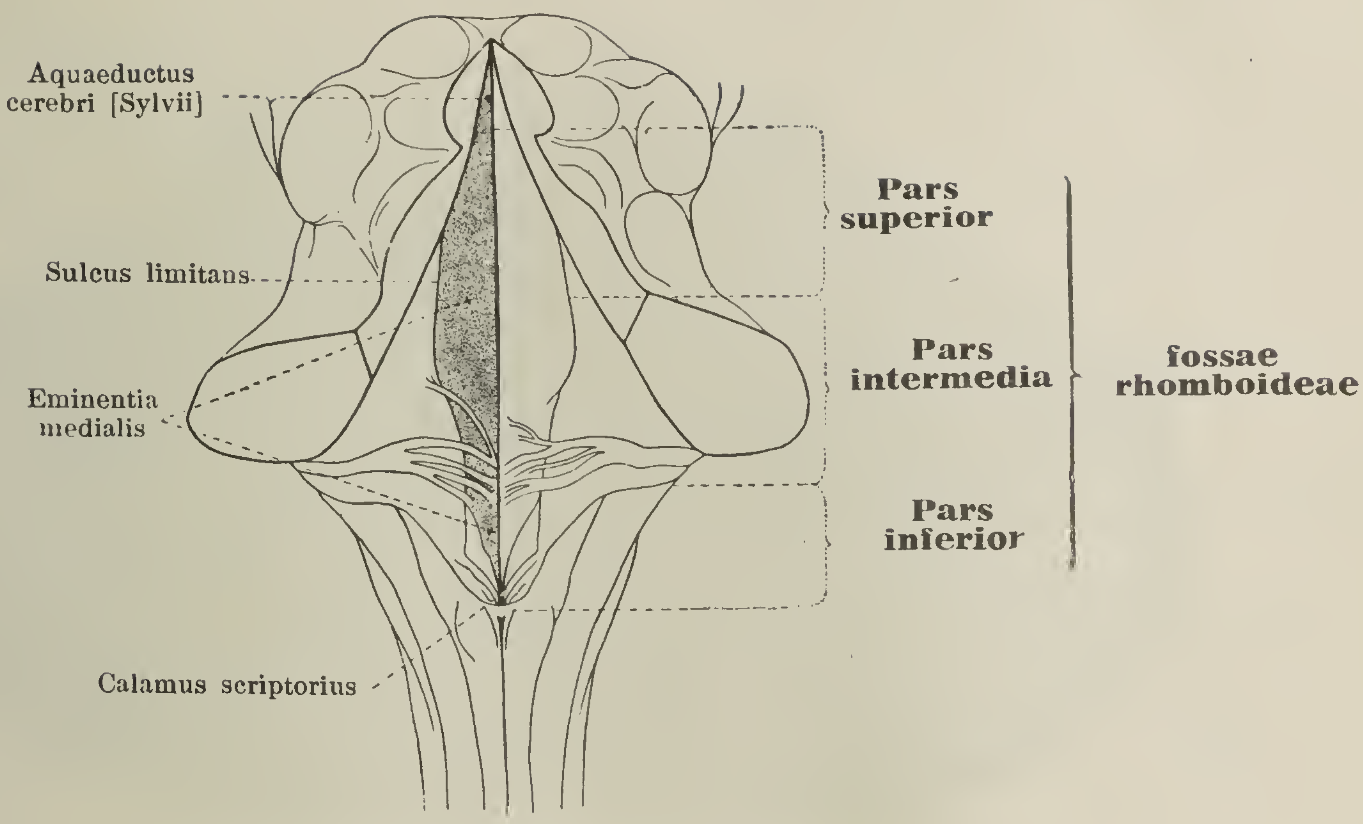
The ***fossa rhomboidea*** *(lozenge-shaped fossa)* (see Figs. 751, 752 and 805) is a rhombic, slightly depressed, generally grayish area, which lies in a nearly vertical plane; it is visible as the floor of the fourth ventricle after the removed of the cerebellum and the thin tela chorioidea ventriculi quarti; only its lower part, embraced by the corpora restiformia, belongs to the medulla oblongata (the myelencephalon); the middle part lies in the metencephalon, and the uppermost part belongs to the isthmus. The lower part *(pars inferior fossae rhomboideae)* is approximately triangular and contains at its inferior angle the opening of the canalis centralis; it appears much deepened below and is marked there by several furrows which converge downward and medianward; this peculiar configuration of the surface has led to the further name *calamus scriptorius.* Along its lateral and inferior margin the tela chorioidea ventriculi quarti (see also Figs. 750, 751 and 756) is attached; when this is forcibly removed it leaves behind it a fine jagged edge, a part of the *taenia ventriculi quarti*, which covers the lowermost apex of the rhomboid fossa from behind as a thin triangular plate, called the *obex.* The taenia, above, bends around sharply lateralward upon the corpus restiforme and there forms the lower boundary of the *pars intermedia fossae rhomboideae;* this pars intermedia on each side, with the *recessus lateralis fossae rhomboideae*, passes far lateralward over the corpus restiforme, but above, between the brachia pontis, becomes considerably narrower and goes over at the upper end of the fovea superior (see p. 650) into the *pars superior fossae rhomboideae.* The pars superior is bounded lateralward by the brachia conjunctiva and covered behind by the velum medullare anterius; it becomes much narrower above and goes over insensibly in front of the lamina quadrigemina into the aquaeductus cerebri. The rhomboid fossa is divided into two symmetrical halves by the *sulcus medianus fossae rhomboideae* which runs in the median plane; the sulcus is deeper below, shallower above. Close to this fossa, on each side, extending through the whole length of the fossa, is a ridge, the *eminentia medialis;* in the pars superior it occupies the whole breadth (produced by the genu [internum] radicis n. facialis and the nucleus n. abducentis); in the upper part of the pars intermedia it presents an elongated projection, the *colliculus facialis;* from this point on, downward, it tapers, at first gradually, but in the pars inferior rather suddenly, so as to form there a right-angled triangular area, *trigonum n. hypoglossi.*



751. Rhomboid fossa, viewed from behind. Magnification: 2:1.
(The cerebellum and the choroid plexus of the fourth ventricle have been completely removed; the brachia conjunctiva with the velum medullare anterius and the lamina quadrigemina have been partly removed.)

Fossa rhomboidea (continued) (see also Figs. 752 and 805).

The eminentia medialis is bounded lateralward by the *sulcus limitans.* This runs, in the pars superior, along the lateral margin and is accompanied there for a considerable distance by a grayish-blue or dark-brown colored area, the *locus caeruleus.* Near the colliculus facialis the sulcus limitans broadens out to form a flat fossa, *fovea superior,* which is usually of a bluish color owing to the presence of a superficial vein; the sulcus ends in the uppermost part of the pars inferior in a sharply marked depression, *fovea inferior.* The narrow, somewhat depressed triangular area beneath the latter which extends not quite so far as the lower margin of the rhomboid fossa, is of a dark gray color and is called the *ala cinerea;* before it lie sensory nuclei of the nn. glossopharyngeus and vagus. Lateral from the sulcus limitans in the pars intermedia and from the ala cinerea of the pars inferior is a flattened elevation, the *area acustica* (here lie nuclei of the n. vestibularis), which, medianward, ends in a convex arch, and lateralward extends into the recessus lateralis to end there in the *tuberculum acusticum* (usually but poorly developed in man); here lies the nucleus of the n. cochlearis dorsalis. Running transversely over the area acustica and over the neighboring part of the eminentia medialis are certain superficial bands of white fibres, *striae medullares* (see also p. 700), which arise on the surface of the tuberculum acusticum and disappear in the depth in the sulcus medianus or before going that far; the striae are very variable in number and size; they run parallel to one another or diverge as they pass medianward.



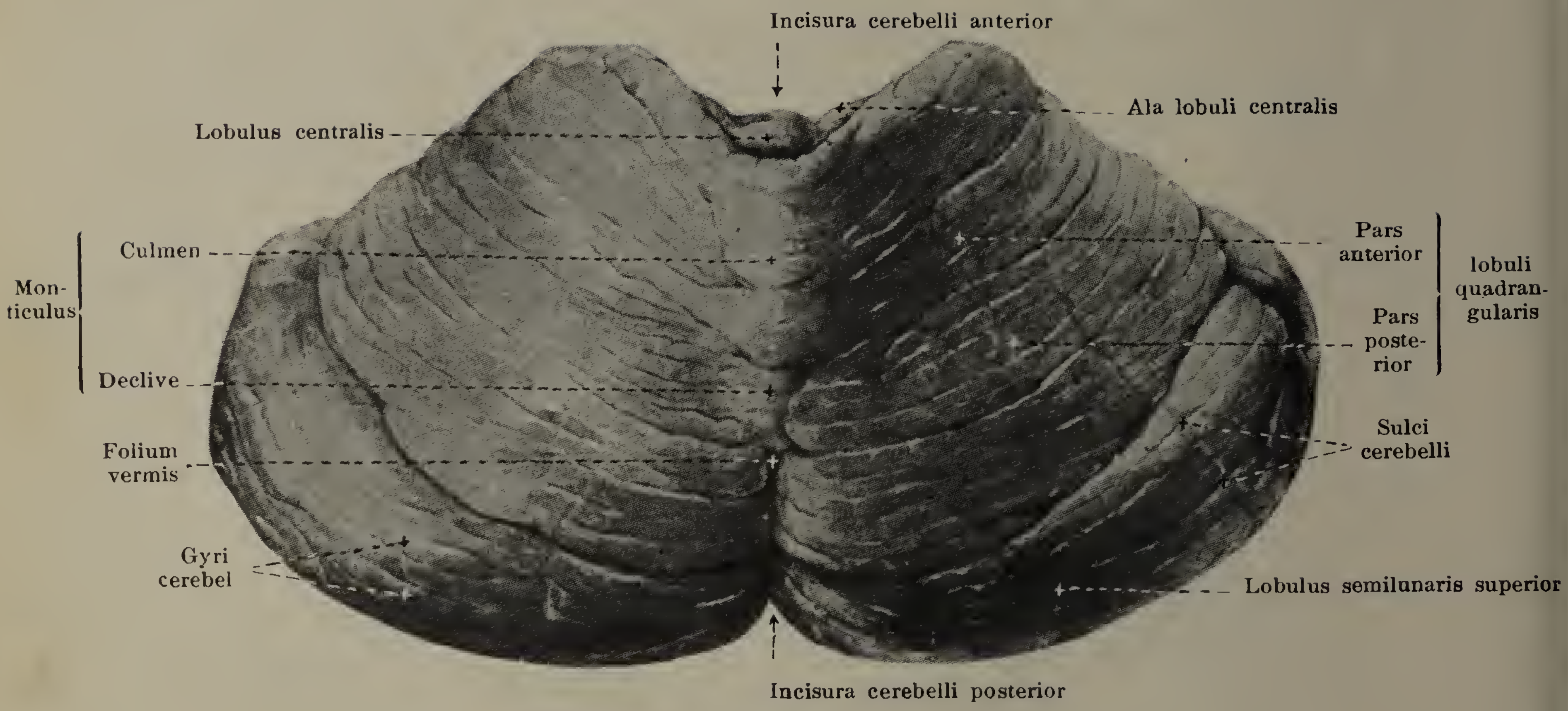
752. Rhomboid fossa,

viewed from behind, partly schematic. Magnification: 11 : 10.

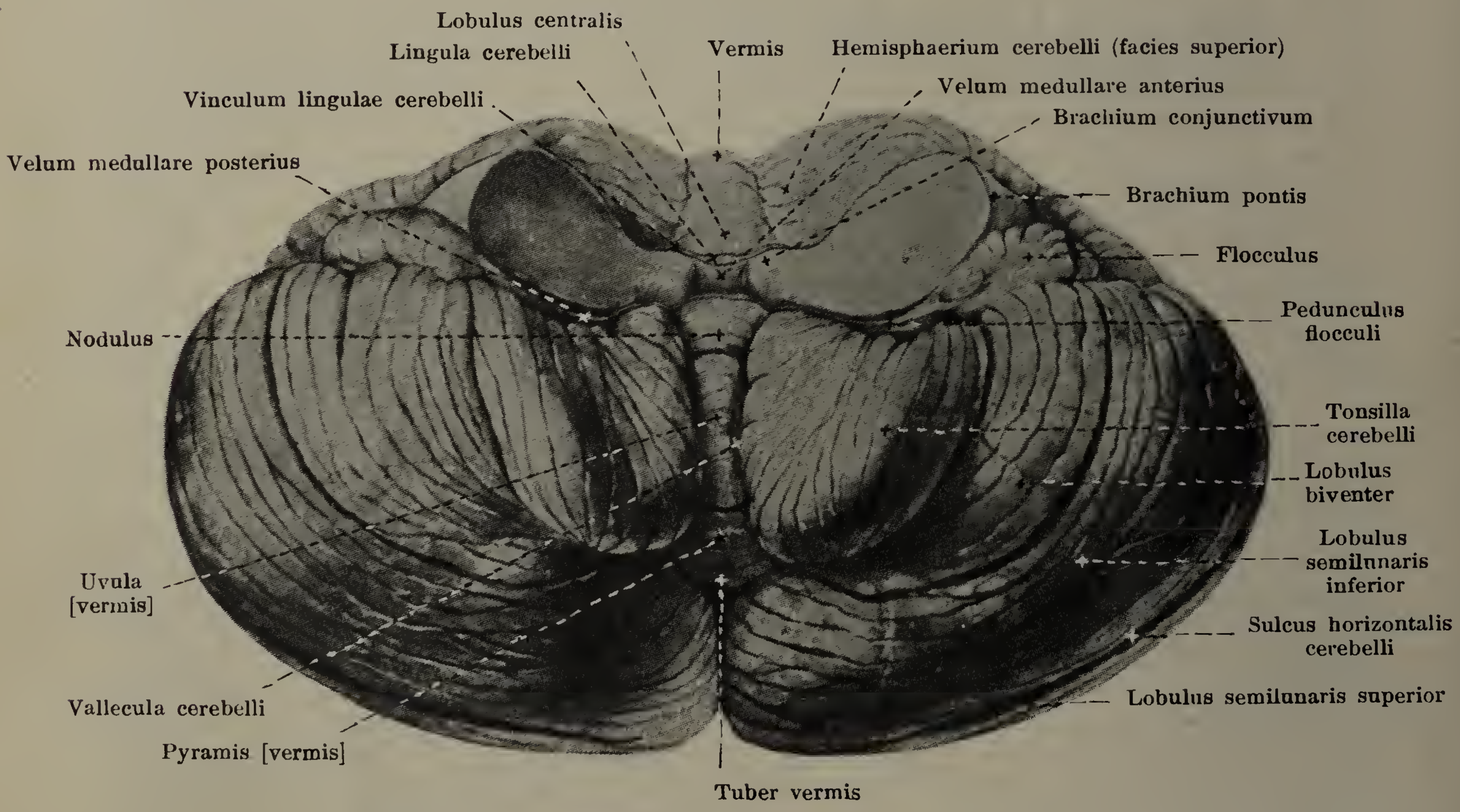
(The left eminentia medialis is shaded.)

The **bridge** *(pons [Varoli])* (see Figs. 748—750, 755 and 758) forms a broad, white mass, running transversely, which is sharply marked off at its lower, posterior margin from the medulla oblongata and at its upper, anterior margin just as distinctly from the cerebral peduncles which pass through it; it lies upon the clivus and reaches upward as far as the upper margin of the dorsum sellae (see Fig. 815). It is convex forward in both sagittal and transversal directions, but presents in the median plane a flat longitudinal groove, the *sulcus basilaris*, which is broader above than below and in which, as a rule, the a. basilaris runs. Broad bundles of fibres can be seen passing in transversal direction on its surface; they converge somewhat lateralward where they become interwoven with one another; usually one broad band of fibres, *fasciculus obliquus [pontis]*, emerges from the general mass medial from the superficial origin of the n. trigeminus and runs on the surface, in a curve convex lateralward, to the region of superficial origin of the nn. facialis and acusticus. Lateralward from this bundle the pons narrows considerably on each side, since the upper, anterior margin curves markedly downward and backward, while the inferior, posterior margin runs further in the transversal direction. Lateralward from a line which connects the superfical origin of the n. trigeminus with that of the n. facialis the mass is designated the *brachium pontis (arm of the pons)* [O. T. middle peduncle of the cerebellum]; it passes lateralward and backward between the flocculus and the lobulus quadrangularis into the substance of the cerebellum. Certain small bundles of nerve fibres, very variable, known as the *fila lateralia pontis* (see Figs. 750 and 757), arise in the groove between the brachium conjunctivum and the brachium pontis, and run medianward along the upper boundary of the brachium pontis and the pons to disappear in the fossa interpeduncularis in the cerebral peduncle.

The **cerebellum** *(small brain)* (see Figs. 748, 753—755 and 758) has the shape of a flattened egg with its longest diameter directed transversely; it lies dorsalward from the upper part of the medulla oblongata, from the rhomboid fossa, and from the brachia conjunctiva and corpora quadrigemina, and with the brachia pontis and the pons forms a ring through which the structures lying in the floor of the rhomboid fossa appear to have been thrust. It fills up completely the fossae occipitales inferiores lying below the sulcus transversus of the occipital bone, extends above as far as the tentorium cerebelli and is separated by this from the occipital lobe of the cerebrum. Below, on each side, the tonsilla cerebelli and the lobulus biventer very often project slightly through the foramen magnum into the vertebral canal. The upper surface of the cerebellum, directed also dorsalward, is curved in the sagittal and frontal directions so as to be convex backward and upward; the lower surface, looking forward and also ventralward is likewise arched in both directions, and presents in the middle a broad groove, formed by the nodulus, the uvula and the tonsillae, called the *vallecula cerebelli*, in which the medulla oblongata is situated. The anterior margin of the upper surface presents in the middle a flat notch, *incisura cerebelli anterior*, which corresponds to the neighboring corpora quadrigemina; on the posterior margin, in the median plane is a deep, narrow notch, *incisura cerebelli posterior*.

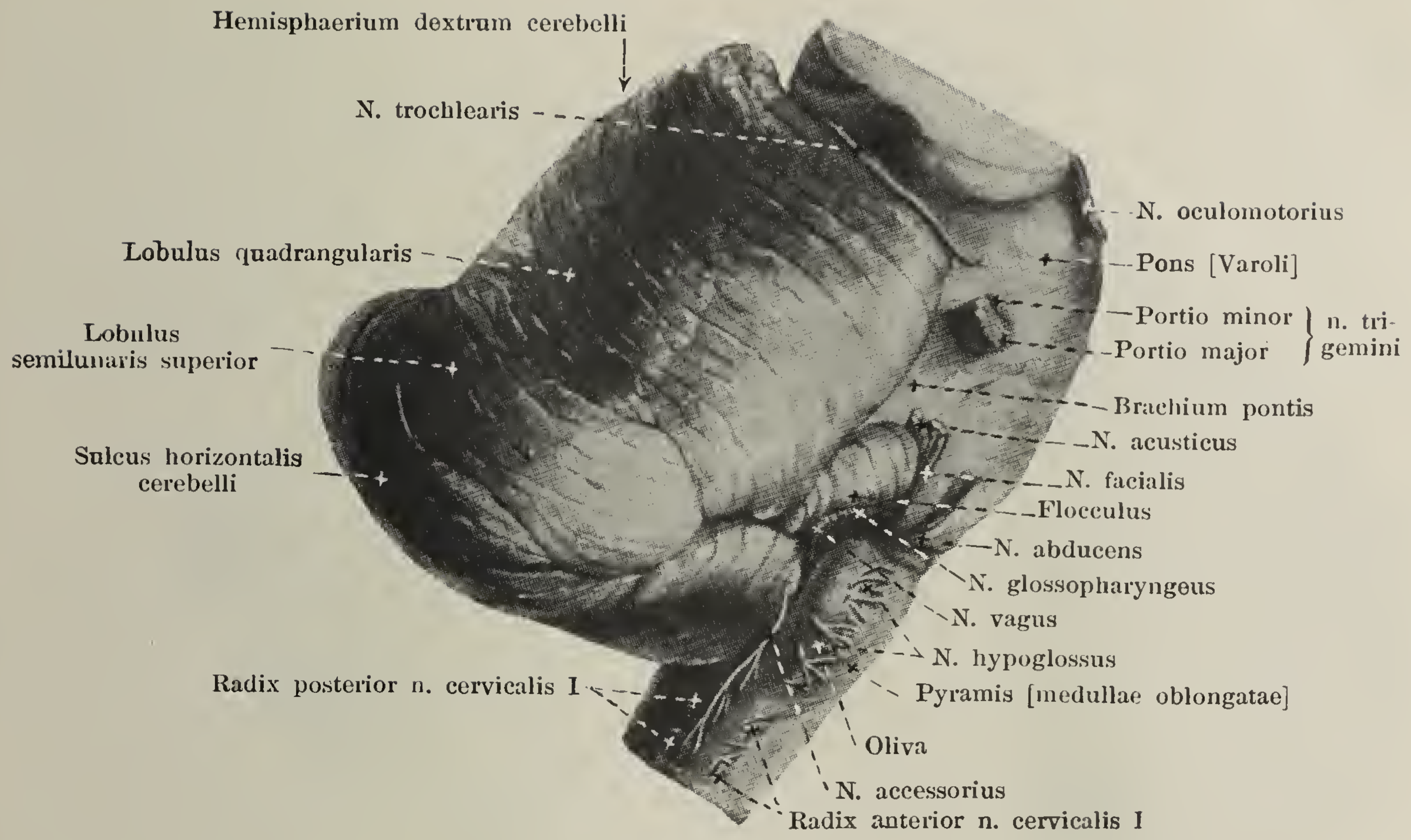


753. Cerebellum, viewed from above and behind.



754. Cerebellum, viewed from below and in front.

(In both figures the cerebellum has been freed by cutting through the brachia pontis, the brachia conjunctiva and the velum medullare anterius.)



755. **Rhombencephalon,** viewed from the right side.

(The cerebrum has been removed by cutting through the cerebral peduncles and the corpora quadrigemina.)

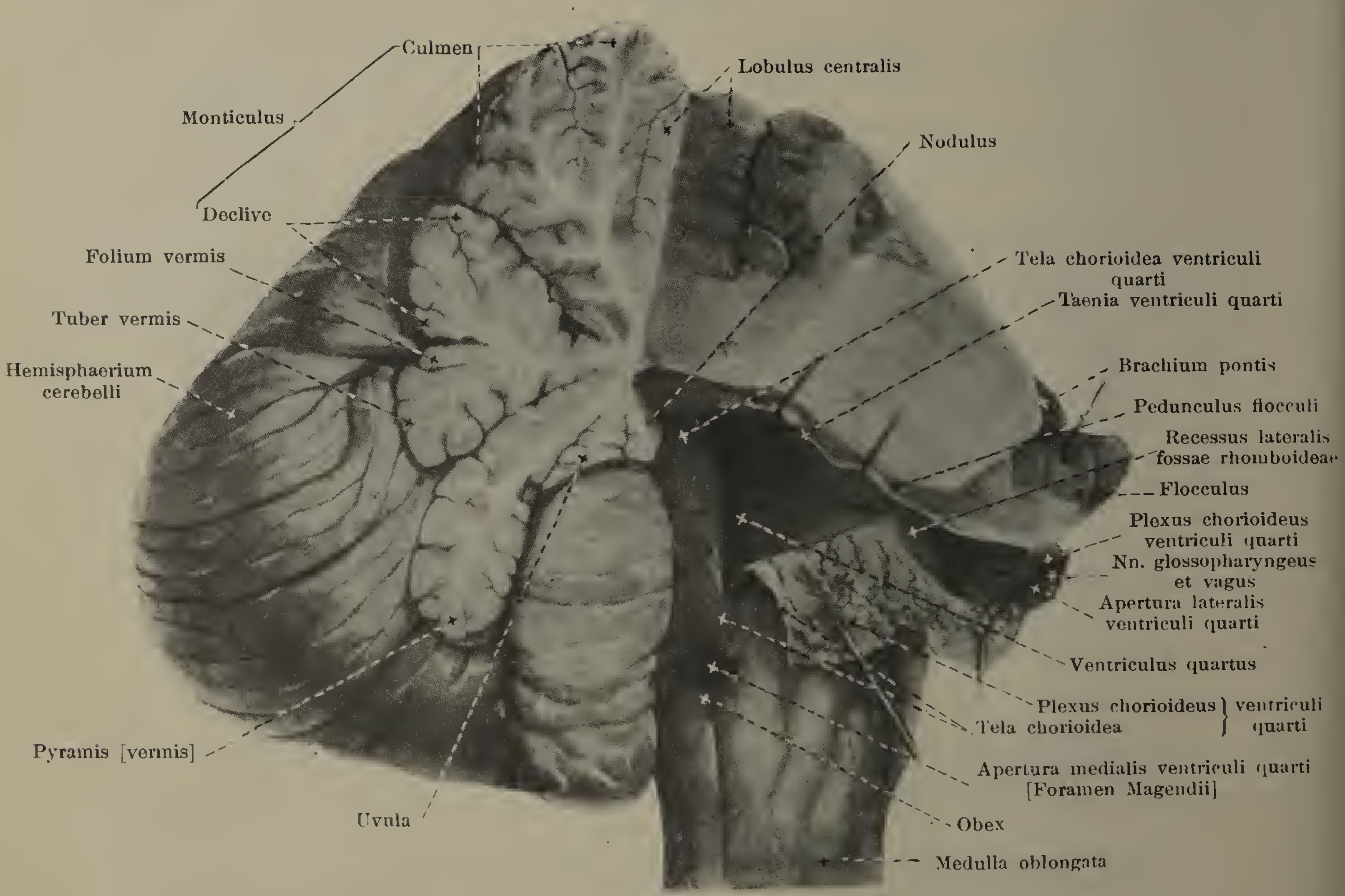
Cerebellum (continued) (see also Figs. 748, 753, 754 and 758).

The medial portion, situated between the incisura anterior and the incisura posterior, is called the *worm (vermis).* It is distinctly separated from the two lateral parts on the inferior surface but very indistinctly on the superior; each of these lateral portions is called a *cerebellar hemisphere (hemisphaerium cerebelli).* The *convolutions, gyri cerebelli,* are separated from one another by numerous narrow *grooves, sulci cerebelli,* which extend continuously, especially on the superior surface, over the worm and the hemispheres and run approximately parallel to the posterior margin. A deeper sulcus, *sulcus horizontalis cerebelli,* extends along the posterior margin or rather upon the inferior surface; it divides the surface of the hemispheres into a *facies superior* and a *facies inferior.* Other deep sulci separate individual lobules from one another, each involving both hemispheres and worm so that one lobule of the worm always corresponds to a similar lobule of the hemisphere. On the upper surface of the worm, from before backward, the following structures are met with: *lingula cerebelli* (see p. 655), *lobulus centralis, monticulus,* in which are to be distinguished *culmen* and *declive,* and the narrow *folium vermis;* on the hemispheres: the delicate *vinculum lingulae cerebelli* (see p. 655), the narrow *ala lobuli centralis,* the *lobulus quadrangularis* which consists of a *pars anterior* and a *pars posterior,* and the *lobulus semilunaris superior.* On the inferior surface of the worm, passing from behind forward are to be seen: the *tuber vermis,* the *pyramis [vermis],* the *uvula [vermis]* .and the *nodulus;* on the hemispheres, the *lobulus semilunaris inferior,* the *lobulus biventer,* and surrounded lateralward by it, the *tonsilla cerebelli* and the *flocculus.* The latter is a club-shaped lobule situated in front of the lobulus biventer and the tonsilla cerebelli and just behind the brachium pontis; it tapers out medianward to the *pedunculus flocculi* and then goes over into a thin leaflet, *velum medullare posterius,* which lies in contact with the front of the nodulus; flocculus, pedunculus flocculi and velum medullare posterius are in direct contact with the lamina epithelialis of the tela chorioidea ventriculi quarti (see p. 654).

The cerebellum is united on each side with the medulla oblongata by means of the corpus restiforme, with the pons by means of the brachium pontis, and with the cerebrum by means of the brachium conjunctivum. These connecting bundles are crowded closely together at the anterior part of the cerebellum.

The **fourth ventricle** *(ventriculus quartus)* (see Figs. 748 and 756), situated within the rhombencephalon, is a cavity containing a small amount of fluid, continuous below with the central canal of the spinal cord and going, above, directly over into the aquaeductus cerebri. On the whole, it is a transverse slit of the form of the rhomboid fossa, and is nowhere deep except in the middle of its length.

Its anterior wall *(floor of the 4th ventricle)* is formed by the rhomboid fossa (see p. 649).


Culmen
Monticulus
Lobulus centralis
Nodulus
Declive
Folium vermis
Tuber vermis
Hemisphaerium cerebelli
Tela chorioidea ventriculi quarti
Taenia ventriculi quarti
Brachium pontis
Pedunculus flocculi
Recessus lateralis fossae rhomboideae
Flocculus
Plexus chorioideus ventriculi quarti
Nn. glossopharyngeus et vagus
Apertura lateralis ventriculi quarti
Ventriculus quartus
Plexus chorioideus } ventriculi quarti
Tela chorioidea
Pyramis [vermis]
Apertura medialis ventriculi quarti [Foramen Magendii]
Uvula
Obex
Medulla oblongata

756. Fourth ventricle,

partly opened, viewed from behind and from the right.

(The right half of the cerebellum has been in large part removed; the tela chorioidea ventriculi quarti has been cut through on the right side and reflected.)

Fourth ventricle (continued) (see also Fig. 748).

Its posterior wall *(roof of the 4th ventricle)* consists in its upper part of the velum medullare anterius and the brachia conjunctiva (see p. 655); in its lower part it is formed by a thin layer, *tela chorioidea ventriculi quarti* (see p. 674), which extends from the velum medullare posterius, the pedunculus flocculi and the flocculus to the margins of the inferior and middle parts of the rhomboid fossa. This layer is lined on its ventricular surface with epithelium, *lamina chorioidea epithelialis*, which, at the margin, is continuous with the brain substance, and which embryologically is a very thin part of the brain wall, arrested in development early in embryonal life On forcibly opening the ventricle the epithelial layer goes with the tela, tearing along the line of transition into brain substance; the fine, jagged border visible along the margin of the tear is called the *taenia ventriculi quarti;* it runs (see Figs. 750 and 751) along the margin of the pars inferior fossae rhomboideae (see p. 649), then follows the lower margin of the recessus lateralis as far as the posterior surface of the region of origin of the nn. glossopharyngeus and vagus, and turns, further on, to the anterior surface of the flocculus; finally it passes along the pedunculus flocculi and the velum medullare posterius. The main mass of the tela chorioidea is formed by a lamella of the pia mater encephali, which is united by loose subarachnoideal tissue with the covering (also formed by pia mater) of the under surface of the worm and of the tonsillae cerebelli. The tela chorioidea is provided on its ventricular surface with lobulated, villus-like, reddish, vascular processes, known as the *plexus chorioideus ventriculi quarti;* they run as two parallel bands close to the median plane in the lower part of the ventricle, are united with one another above and then bend around at a right angle into the recessus laterales; the free ends of the plexus project for a variable distance through the three openings of the ventricle (see p. 655) and hang in the subarachnoidal spaces, so that in the undissected brain the lateral end can be seen on each side, in the angle between the flocculus, nn. facialis and acusticus on the one hand, and the tonsilla cerebelli, nn. glossopharyngeus and vagus on the other (see Fig. 758).

The tela chorioidea is completely closed originally, but is regularly broken through later in the 4th embryonal month at three places; these openings (see Figs. 756 and 815) unite the subarachnoideal spaces with the fourth ventricle; they are of variable size. One unpaired opening, *apertura medialis ventriculi quarti [foramen Magendii]*, lies just over the obex at the lower end of the posterior wall of the ventricle; the other paired opening, *apertura lateralis ventriculi quarti*, corresponds approximately to the apex of the recessus lateralis and lies upon the posterior surface of the roots of the nn. glossopharyngeus and vagus.

The angle formed by the meeting of the velum medullare anterius and the velum medullare posterius, very distinct in the median section (see Fig. 748), is called the *fastigium*.

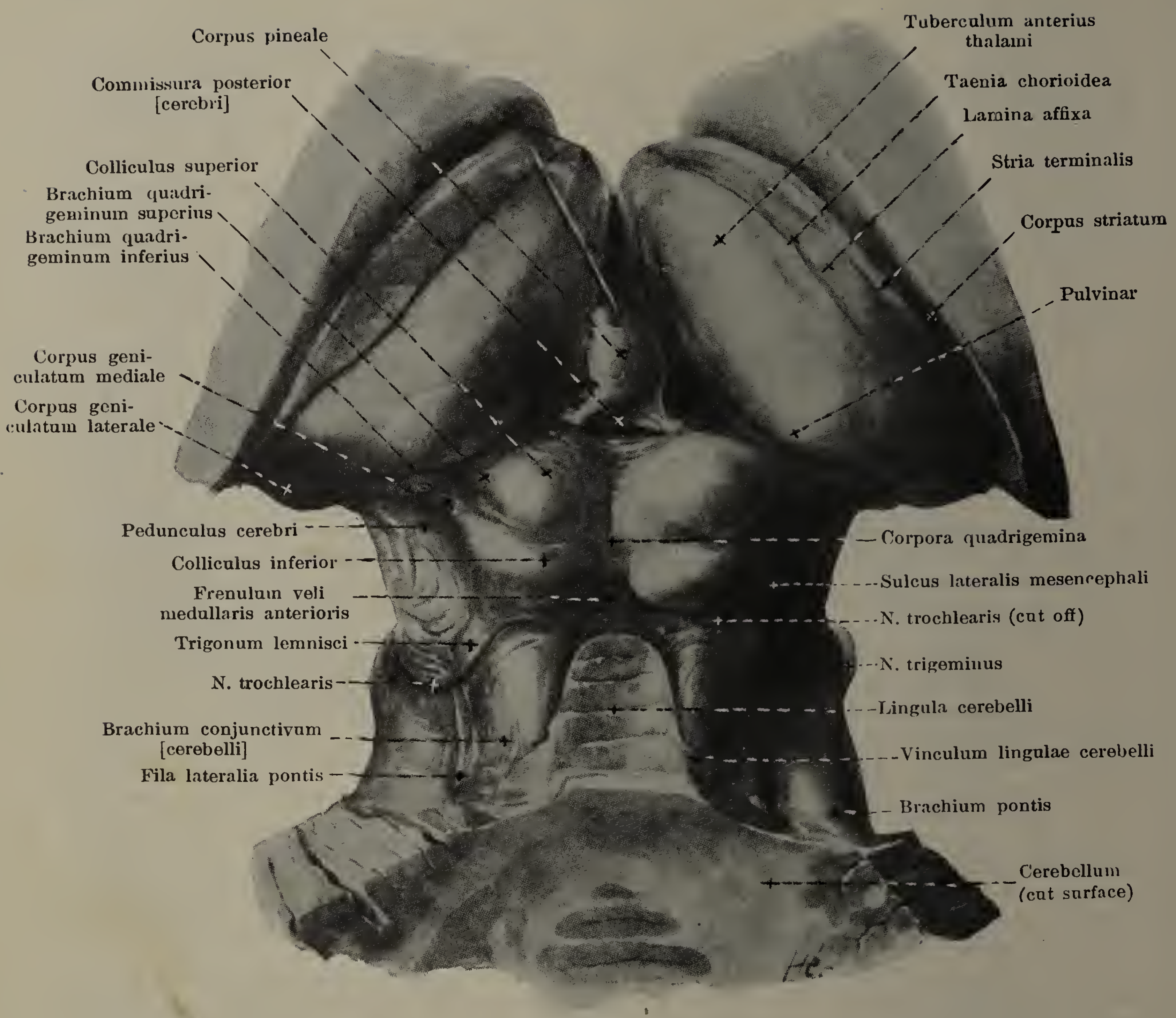
The transverse slit which passes upward between the posterior surface of the medulla oblongata and the anterior surface of the cerebellum is called the *fissura transversa cerebelli*.

Isthmus rhombencephali and mesencephalon.

The ***brachia conjunctiva cerebelli*** (O. T. superior cerebellar peduncles) are two flat, striped, white bundles which pass out of the anterior portion of the cerebellum (see Figs. 750, 754 and 757), converge as they pass upward and disappear beneath the lamina quadrigemina. Laterally each one fuses, below with the brachium pontis, above with the pedunculus cerebri; the junction of these structures is indicated on the surface by a groove, *sulcus lateralis mesencephali*, which is continued upward as far as the medial geniculate body. Stretching out between the medial margins of the brachia conjunctiva is an unpaired, thin, white leaflet, *velum medullare anterius* (see also Figs. 748 and 754), which is directly connected with the cerebellum below and narrows as it passes upward; its anterior surface, with the adjacent parts of the brachia conjunctiva, forms the upper part of the posterior wall of the fourth ventricle, while its posterior surface (see Figs. 748 and 757) is fused with several transverse gray ridges which form the *lingula cerebelli* of the worm; from the latter, on each side, a triangular process, *vinculum lingulae cerebelli*, goes off below and passes lateralward over the brachium conjunctivum. A white strand running from the lower end of the median sulcus of the corpora quadrigemina to the upper end of the velum medullare anterius is called the *frenulum veli medullaris anterioris;* the n. trochlearis emerges lateralward from it on each side, just beneath the inferior colliculus. The upper part of the lateral surface of the brachium conjunctivum is overlapped by a triangular area, *trigonum lemnisci* (see Fig. 750), which projects somewhat but is not always well defined; the fibres directed obliquely medianward, dorsalward and upward belong to the *lemniscus (fillet)* — to the *lemniscus lateralis [acusticus];* this area is bounded lateralward by the sulcus lateralis mesencephali, in front by the brachium quadrigeminum inferius and contains in the depth the *nucleus lemnisci lateralis*.

Directly in contact with the brachia conjunctiva above and in front are the ***corpora quadrigemina*** (see Figs. 748, 750 and 757). These are subdivided by a median flat groove and by a transverse groove passing at right angles to the median groove somewhat behind its middle, sharply marked lateralward, into four, whitish hemispherical elevations, so that a *colliculus inferior* and a *colliculus superior* are formed on each side; the superior colliculi are considerably larger than the inferior, but their convexities are more flattened. In the median groove between the two superior colliculi lies the corpus pineale (see p. 666); it hides them for a variable distance downward (see Fig. 770). The corpora quadrigemina are elevations from a plate, the *lamina quadrigemina* (see Figs. 748 and 787), which goes directly over, on each side, lateralward and in front, into the tegmentum of the pedunculus cerebri; the anterior boundary of this plate corresponds to a plane passing through the aquaeductus cerebri parallel to the posterior surface (see Fig. 787). Each colliculus is continuous lateralward with a *quadrigeminal arm* (see also Fig. 750) directed upward and lateralward, each arm being separated by a groove from its neighbor; the *superior quadrigeminal arm (brachium quadrigeminum superius)* proceeds from the colliculus superior and disappears beneath the medial geniculate body and beneath the pulvinar by which it is partly overlapped; the *inferior quadrigeminal arm (brachium quadrigeminum inferius)*, from the collicus inferior, is longer, passes along the upper margin of the trigonum lemnisci as far as the sulcus lateralis mesencephali, and then disappears beneath the medial geniculate body.

On the anterior inferior surface of the brain-stem (see Figs. 749 and 758) two large, striped white bundles, ***pedunculi cerebri*** (O. T. crura cerebri), are to be seen close to one another; they emerge from the upper margin of the pons and diverging almost at a right angle, pass upward and lateralward to disappear beneath the tractus optici. The ventral surface here visible and the lateral free surface as far as the sulcus lateralis mesencephali (see Fig. 750) belong to the *basis pedunculi (foot of the cerebral peduncle)*, while the area between this sulcus and the lamina quadrigemina overlaid by the trigonum lemnisci and the brachium quadrigeminum inferius belongs to the *tegmentum* (see Fig. 787).



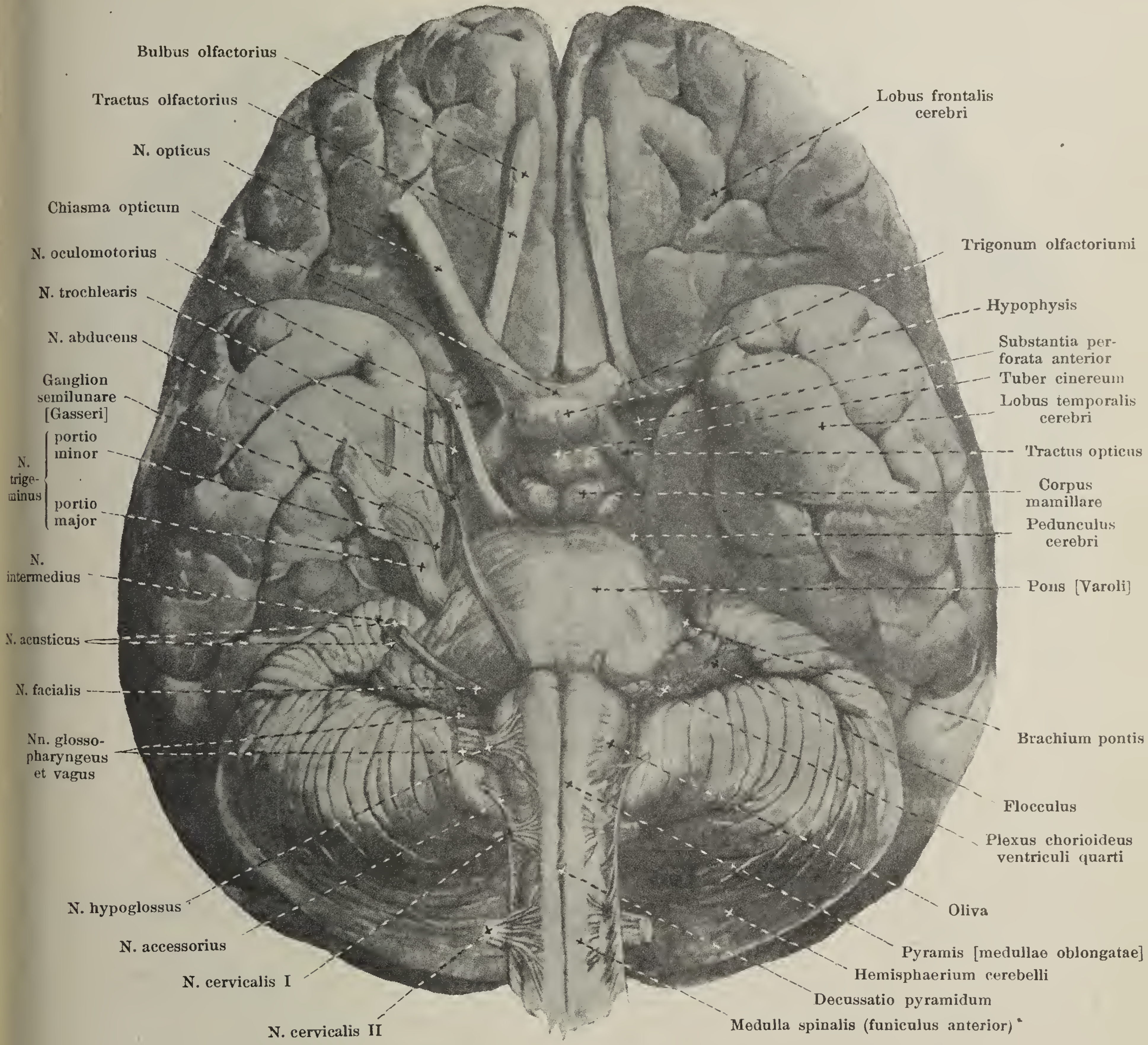
757. Corpora quadrigemina and neighborhood,
viewed from behind and above.

(The upper part of the cerebellum has been removed by a cut passing obliquely backward and downward; the cerebral hemispheres have been removed; the corpus pineale has been pulled upward by a hook.)

Between the diverging cerebral peduncles is a deep depression, *fossa interpeduncularis [Tarini]* (see Fig. 749); its *recessus posterior* slightly undermines the upper margin of the pons and its *recessus anterior* passes into the depth between the corpora mamillaria (see Fig. 748). The floor of this approximately triangular fossa, which reaches upward as far as the corpora mamillaria, is formed by the *substantia perforata posterior*. This surface presents numerous openings for blood vessels, is subdivided by a median shallow groove and helps, on each side, to bound the tegmentum medianward (see Fig. 787). It is marked off from the cerebral peduncle by a groove, the *sulcus n. oculomotorii* (see Fig. 749).

The ***aquaeductus cerebri [Sylvii]*** (see Figs. 748, 784—787, 794 and 795) is a narrow canal, 1,5 cm long, which passes from the upper end of the fourth ventricle (see p. 653) through the mesencephalon to the third ventricle. It is covered behind by the lamina quadrigemina and the commissura posterior; it is bounded in front by the tegmentum of the pedunculus cerebri. In cross-section it is triangular or T-shaped in its upper and lower parts, while in the middle it has approximately the shape of an ace of hearts, though it deviates sometimes from this shape.

The **cerebrum** *(large brain)* (see p. 646) is approximately egg-shaped. It presents a surface, markedly convex upward in the sagittal and frontal directions, *facies convexa cerebri* (see also Figs. 759, 760 and 763), which corresponds to the inner surface of the roof of the skull, and an inferior surface, *basis cerebri* (see Figs. 765 and 766); the front part of the latter lies in the anterior and middle fossae of the skull, the back part upon the tentorium cerebelli which separates it from the cerebellum; its bulgings correspond to the surfaces.



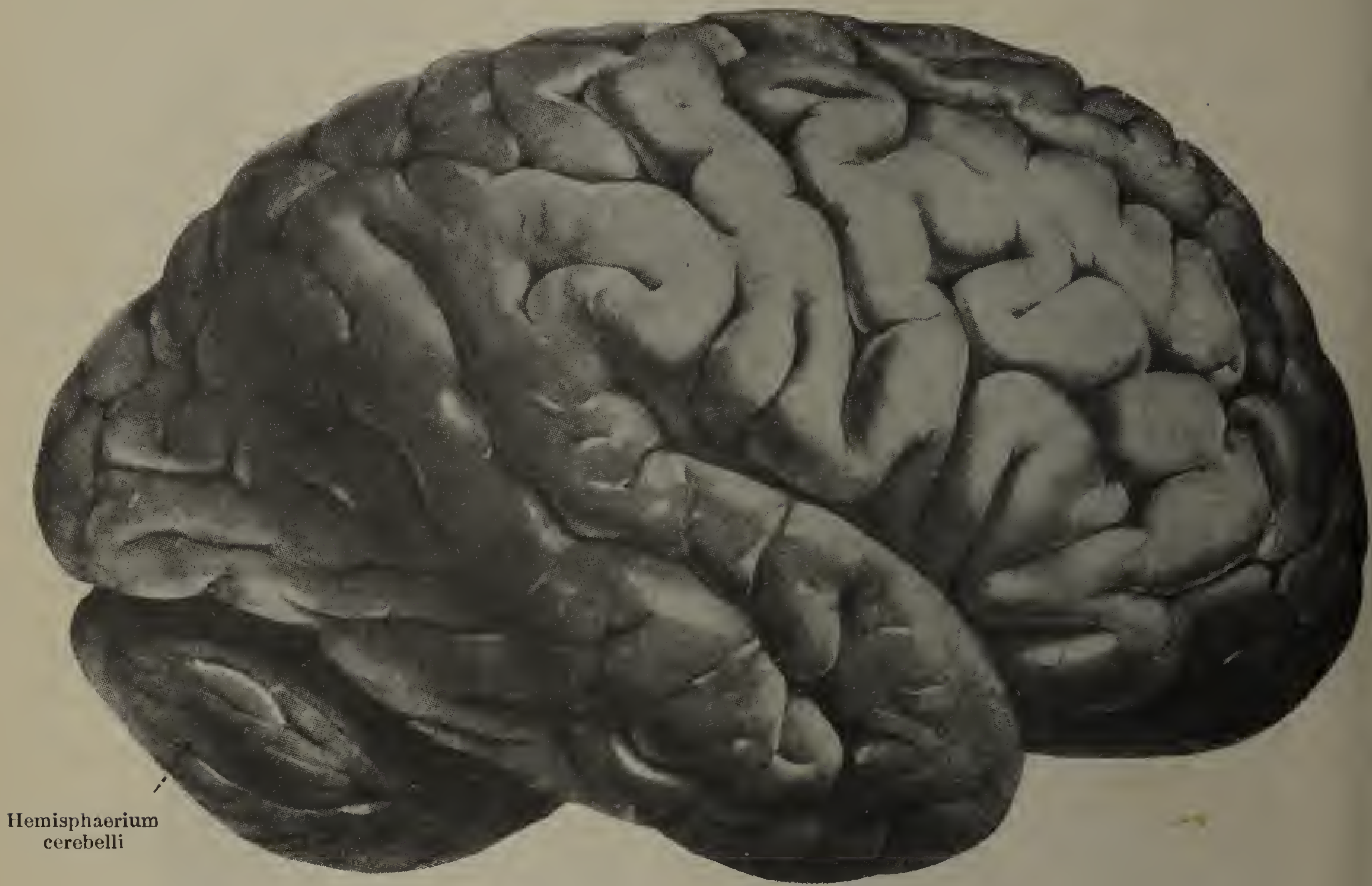
758. Brain, viewed from below and in front.

(The nerves on the left side have been cut off short.)

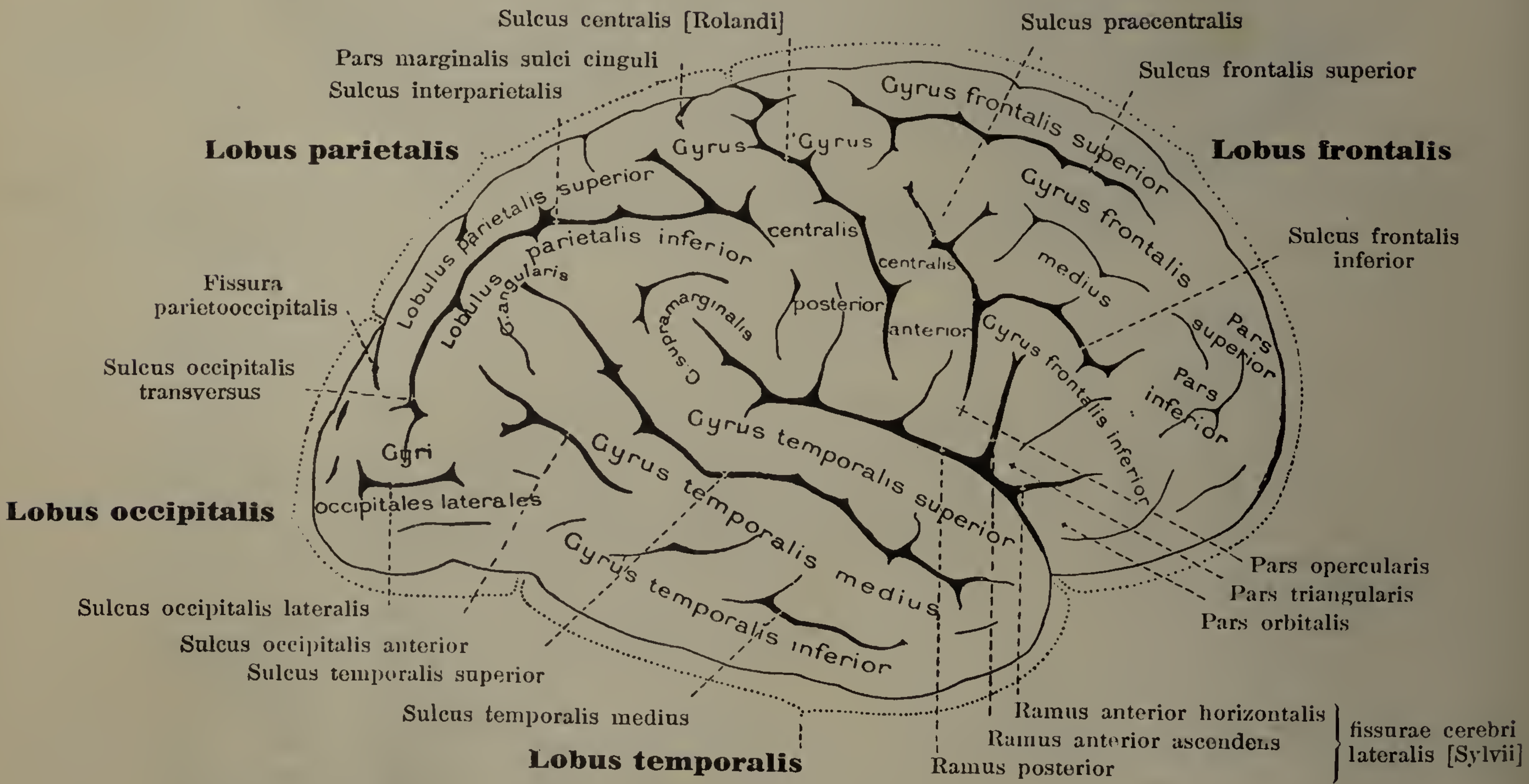
Cerebrum (continued). It is composed of two symmetrical halves, only partly united with one another in the median plane; hence each half presents an approximately flat *facies medialis cerebri* (see Figs. 748, 761 and 762), which belongs partly to the 3rd ventricle, partly to the free surface.

The largest mass of the cerebrum is formed on each side by the ***cerebral hemisphere*** *(hemisphaerium cerebri)*, in which are to be distinguished the *pallium*, the *rhinencephalon* and the (buried) *corpus striatum.*

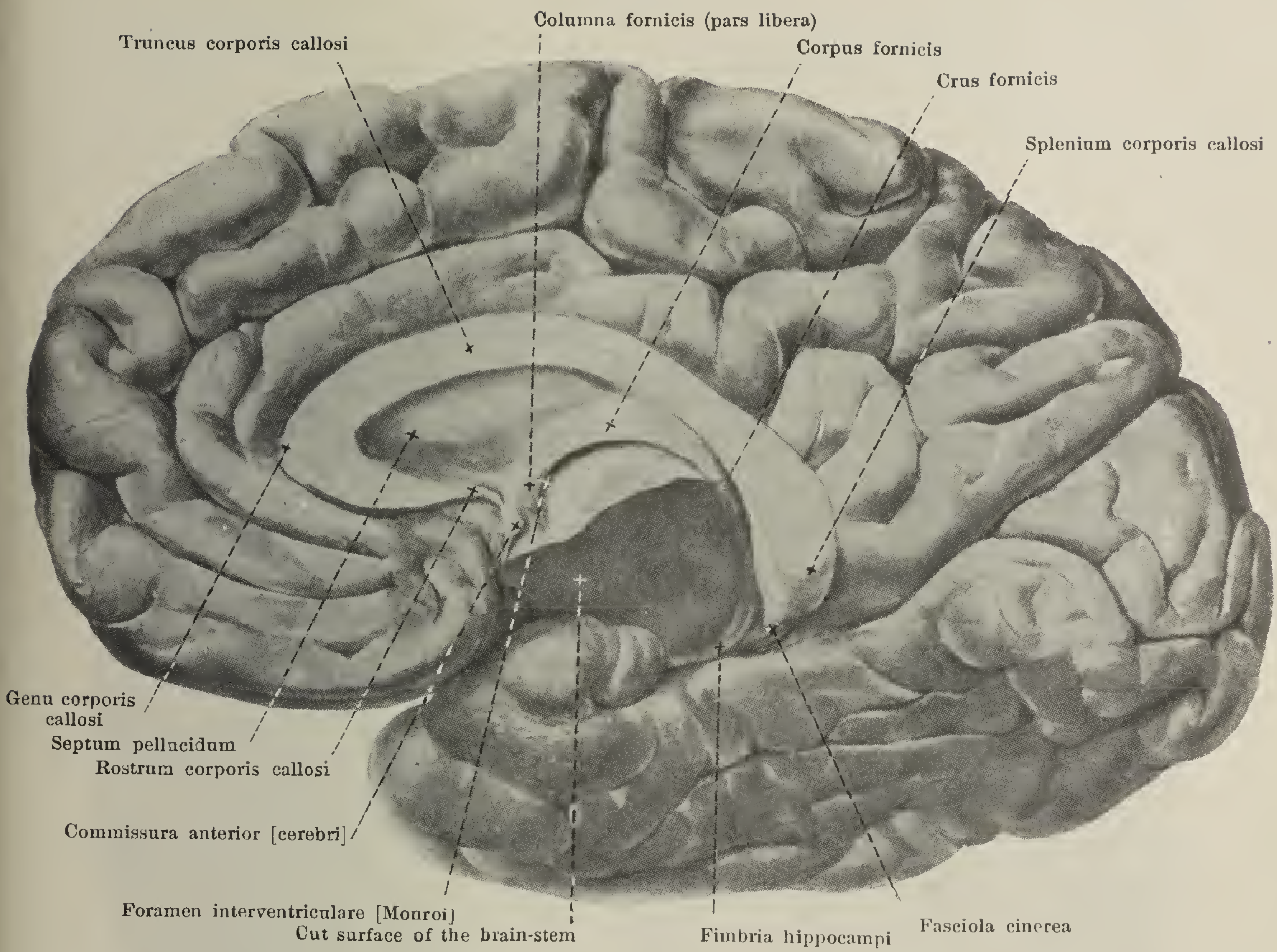
The ***pallium*** *(brain-mantle)* is the main mass of the hemisphere, markedly fissured on the surface; that of one hemisphere is separated from that of the other side by a deep median slit, *fissura longitudinalis cerebri* (see Figs. 763 and 765), reaching to the corpus callosum. The deep transverse slit, which passes in from behind, between the pallium on the one hand and the upper surface of the cerebellum, the corpora quadrigemina and the corpus pineale on the other, filled up behind by the tentorium cerebelli and in front by a duplicature of the pia mater, is called the *fissura transversa cerebri* (see Fig. 747, not designated) (Continnation see p. 660).



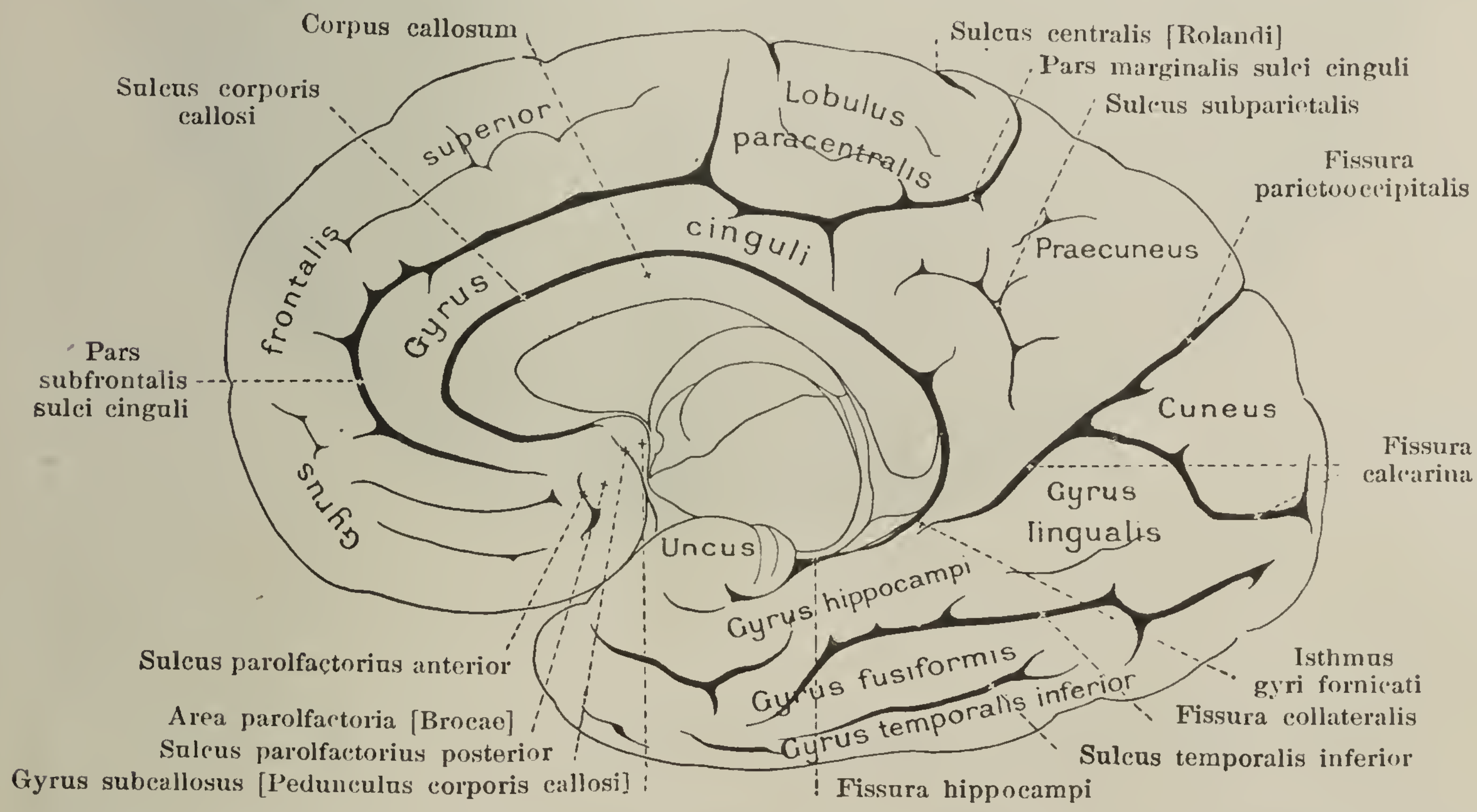
759. Brain, viewed from the right.


Sulcus centralis [Rolandi]
Sulcus praecentralis
Pars marginalis sulci cinguli
Sulcus frontalis superior
Sulcus interparietalis
Lobus parietalis
Lobus frontalis
Gyrus frontalis superior
Gyrus
Gyrus
Lobulus parietalis superior
Gyrus frontalis medius
Lobulus parietalis inferior
centralis
centralis
posterior
anterior
Sulcus frontalis inferior
Fissura parietooccipitalis
G. angularis
G. supramarginalis
Pars superior
Pars inferior
Gyrus frontalis inferior
Sulcus occipitalis transversus
Gyri occipitales laterales
Gyrus temporalis superior
Gyrus temporalis medius
Gyrus temporalis inferior
Lobus occipitalis
Pars opercularis
Pars triangularis
Pars orbitalis
Sulcus occipitalis lateralis
Sulcus occipitalis anterior
Sulcus temporalis superior
Sulcus temporalis medius
Lobus temporalis
Ramus anterior horizontalis
Ramus anterior ascendens
Ramus posterior
fissurae cerebri lateralis [Sylvii]

760. Cerebral hemisphere, viewed from the right, partly schematic.

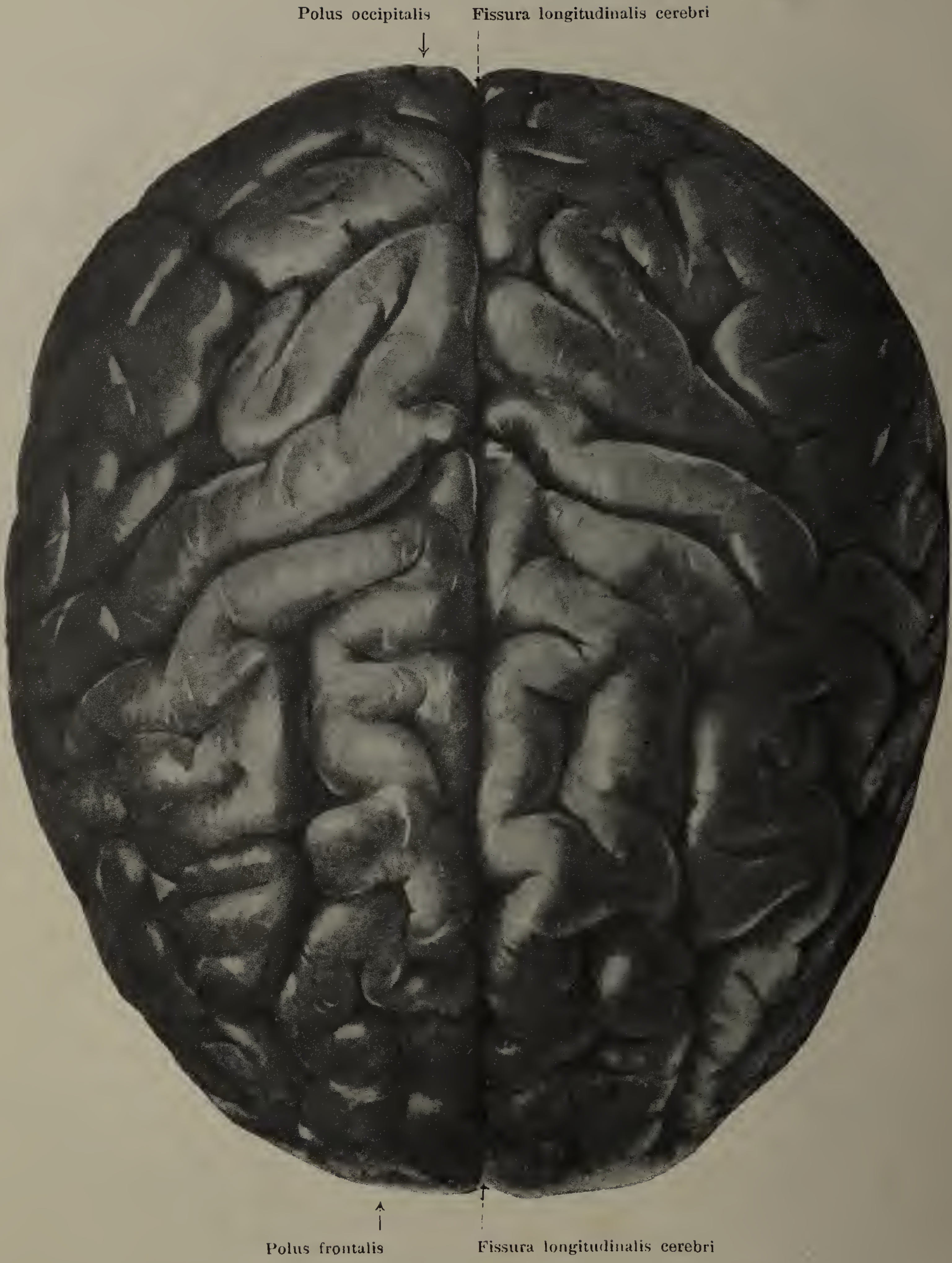


761. **Right cerebral hemisphere,** viewed from the left.


Corpus callosum
Sulcus corporis callosi
Sulcus centralis [Rolandi]
Pars marginalis sulci cinguli
Sulcus subparietalis
Fissura parietooccipitalis
Lobulus paracentralis
superior
frontalis
Gyrus cinguli
Praecuneus
Pars subfrontalis sulci cinguli
Cuneus
Fissura calcarina
Gyrus lingualis
Gyrus
Uncus
Gyrus hippocampi
Gyrus fusiformis
Gyrus temporalis inferior
Sulcus parolfactorius anterior
Area parolfactoria [Brocae]
Sulcus parolfactorius posterior
Gyrus subcallosus [Pedunculus corporis callosi]
Fissura hippocampi
Isthmus gyri fornicati
Fissura collateralis
Sulcus temporalis inferior

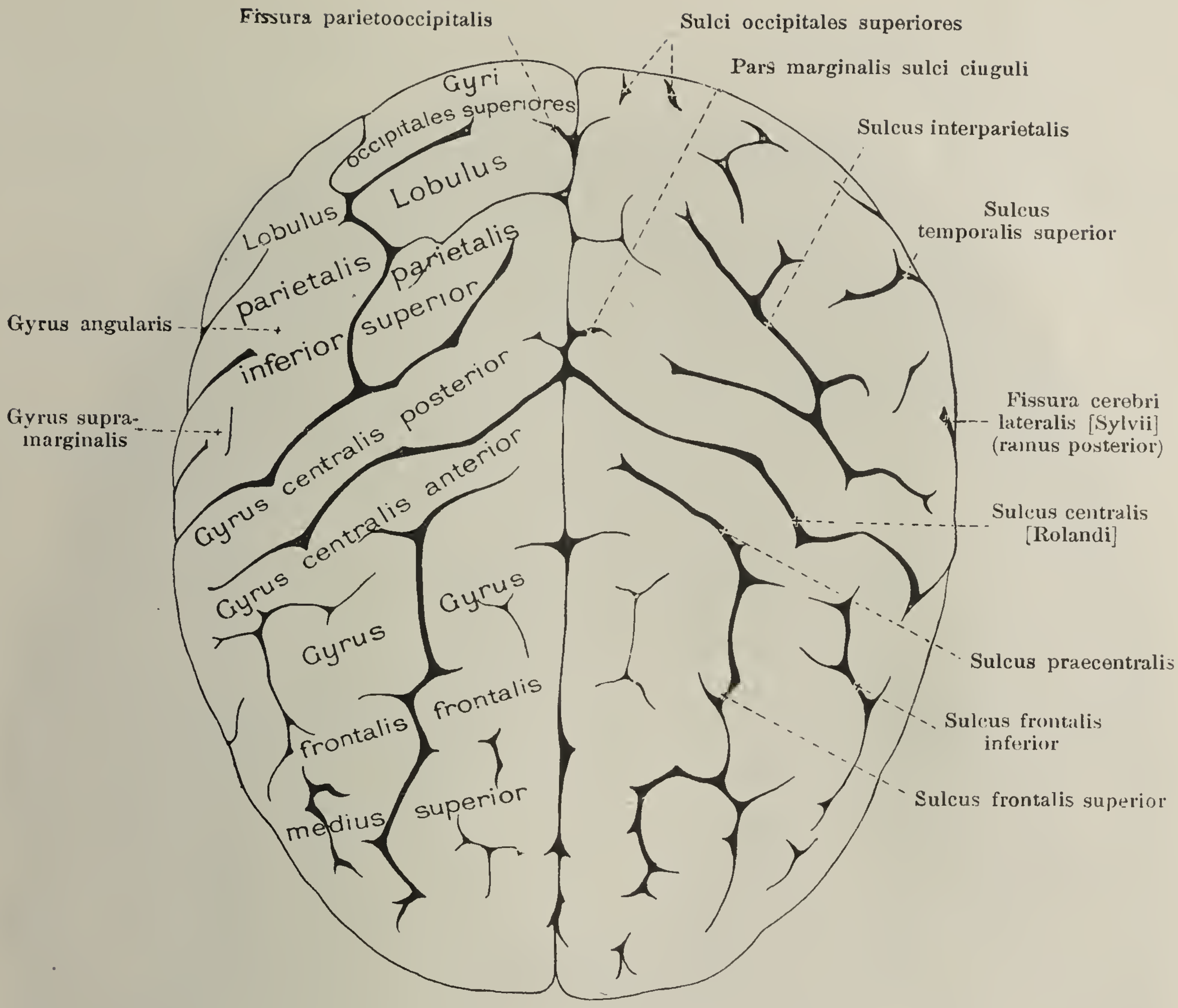
762. **Right cerebral hemisphere,** viewed from the left, partly schematic.

(The brain has been cut in half; the lower part of the brain-stem has been removed by an oblique cut.)


Polus occipitalis
Fissura longitudinalis cerebri
Polus frontalis
Fissura longitudinalis cerebri

763. **Cerebral hemispheres**, viewed from above.

Pallium (continued). What has been said concerning the form of the cerebrum holds for the pallium; on the inferior, basal surface the upper angle of the pyramid of the temporal bone causes a slight depression, *impressio petrosa* (see Fig. 765), which runs obliquely lateralward and dorsalward.

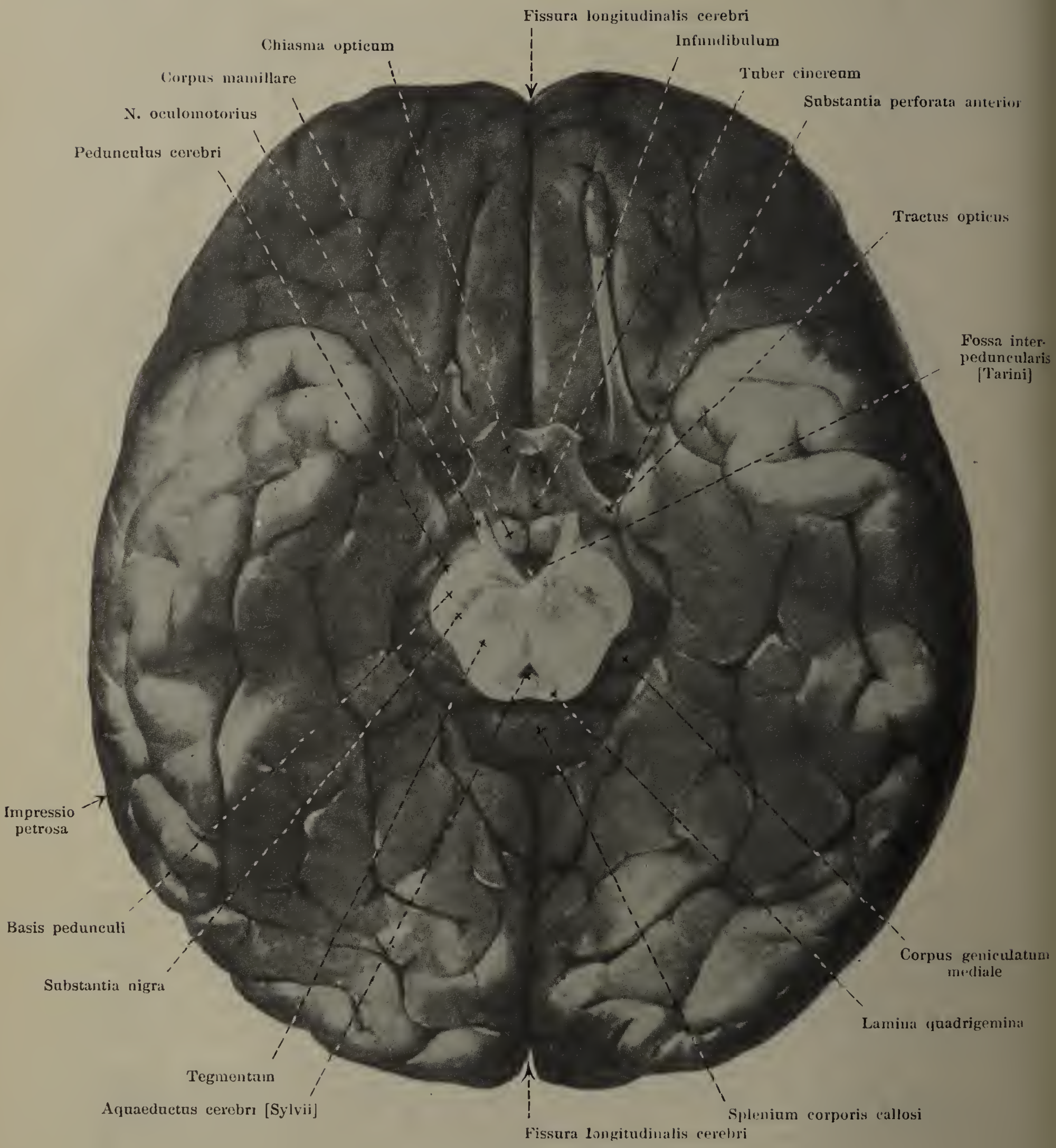

Fissura parietooccipitalis
Sulci occipitales superiores
Pars marginalis sulci ciuguli
Sulcus interparietalis
Sulcus temporalis superior
Gyri occipitales superiores
Lobulus parietalis superior
Lobulus parietalis inferior
Gyrus angularis
Gyrus supramarginalis
Gyrus centralis posterior
Gyrus centralis anterior
Fissura cerebri lateralis [Sylvii] (ramus posterior)
Sulcus centralis [Rolandi]
Sulcus praecentralis
Sulcus frontalis inferior
Sulcus frontalis superior
Gyrus frontalis medius
Gyrus frontalis superior

764. Cerebral hemispheres, viewed from above, partly schematic.

Pallium (continued). The surface is studded by numerous *convolutions, gyri cerebri*, in part individually variable; they are shorter or longer, straight or curved elevations, separated from one another by groove-like or slit-like depressions, ***sulcus cerebri.*** These superficial gyri are manifoldly connected in the depth of the sulci by hidden ***deep gyri, gyri profundi.*** Short gyri which, lying superficially or in the depth, making a connection between two longer gyri are called ***transitional gyri, gyri transitivi*** (O. T. annectant gyri). Those sulci which arise as "primary fissures" in the embryo by a total infolding into the ventricular cavity of the wall of the hemisphere, still very thin at this time, are called *fissurae;* each of these corresponds, therefore, to a projection in the wall of the ventricle, usually similarly named.

On the lateral, convex surface of the pallium (see Figs. 759 and 760) runs the deep, arch-like *fissura cerebri lateralis [Sylvii]* (see also p. 664); it divides into a ***ramus anterior horizontalis***, a ***ramus anterior ascendens***, and a ***ramus posterior.*** The portion of the pallium over its anterior part, reaching as far as the sulcus centralis is called the ***lobus frontalis (frontal lobe);*** that over its posterior part, extending from the sulcus centralis almost to the fissura parietooccipitalis, is the ***lobus parietalis (parietal lobe);*** the part lying beneath it is the ***lobus temporalis (temporal lobe)*** which is very indistinctly marked off from the most posterior portion, ***lobus occipitalis (occipital lobe).*** The most anterior point of the frontal lobe is called the ***polus frontalis***, that of the temporal lobe, the ***polus temporalis***, while the most posterior point of the occipital lobe is called the ***polus occipitalis*** (see also Fig. 766).

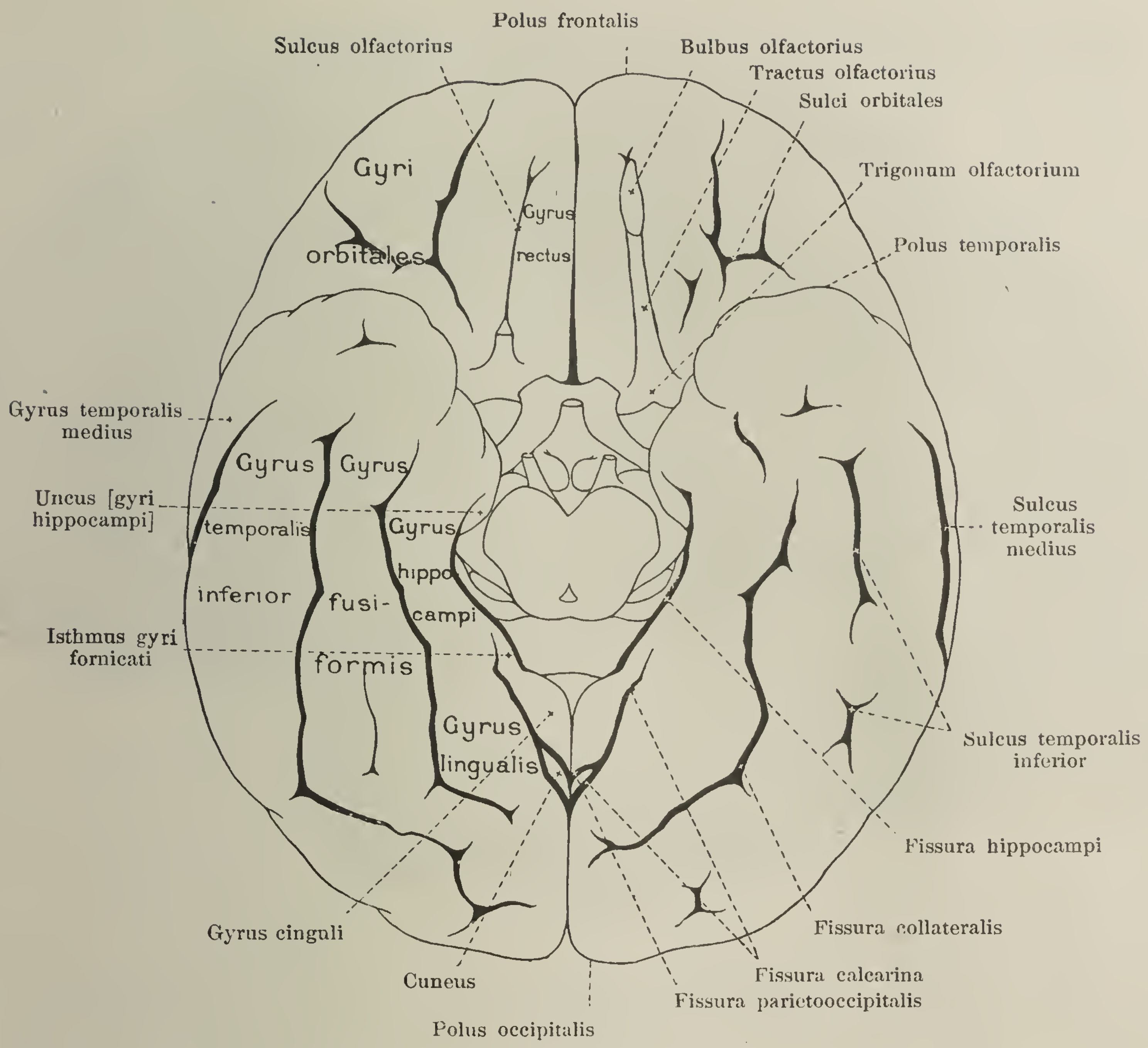
Upon the convex surface of the *frontal lobe* (see also Figs. 759, 760 and 763) above runs the ***sulcus frontalis superior***, below, the ***sulcus frontalis inferior***, which goes over behind into the ***sulcus praecentralis;*** in this way are formed the ***gyrus frontalis superior***, the ***gyrus frontalis medius***, which is again subdivisible in front into a ***pars superior*** and a ***pars inferior***, the ***gyrus frontalis inferior***, divided by the two anterior rami of the fissura cerebri lateralis into a ***pars orbitalis***, a ***pars triangularis*** and a ***pars opercularis***, and the ***gyrus centralis anterior.***


Fissura longitudinalis cerebri
Chiasma opticum
Infundibulum
Corpus mamillare
Tuber cinereum
N. oculomotorius
Substantia perforata anterior
Pedunculus cerebri
Tractus opticus
Fossa interpeduncularis [Tarini]
Impressio petrosa
Basis pedunculi
Corpus geniculatum mediale
Substantia nigra
Lamina quadrigemina
Tegmentum
Aquaeductus cerebri [Sylvii]
Splenium corporis callosi
Fissura longitudinalis cerebri

765. Base of cerebrum *(basis cerebri),* viewed from below.
(The rhombencephalon has been cut off transversely, just above the pons. The hypophysis and the right tractus olfactorius have been removed.)

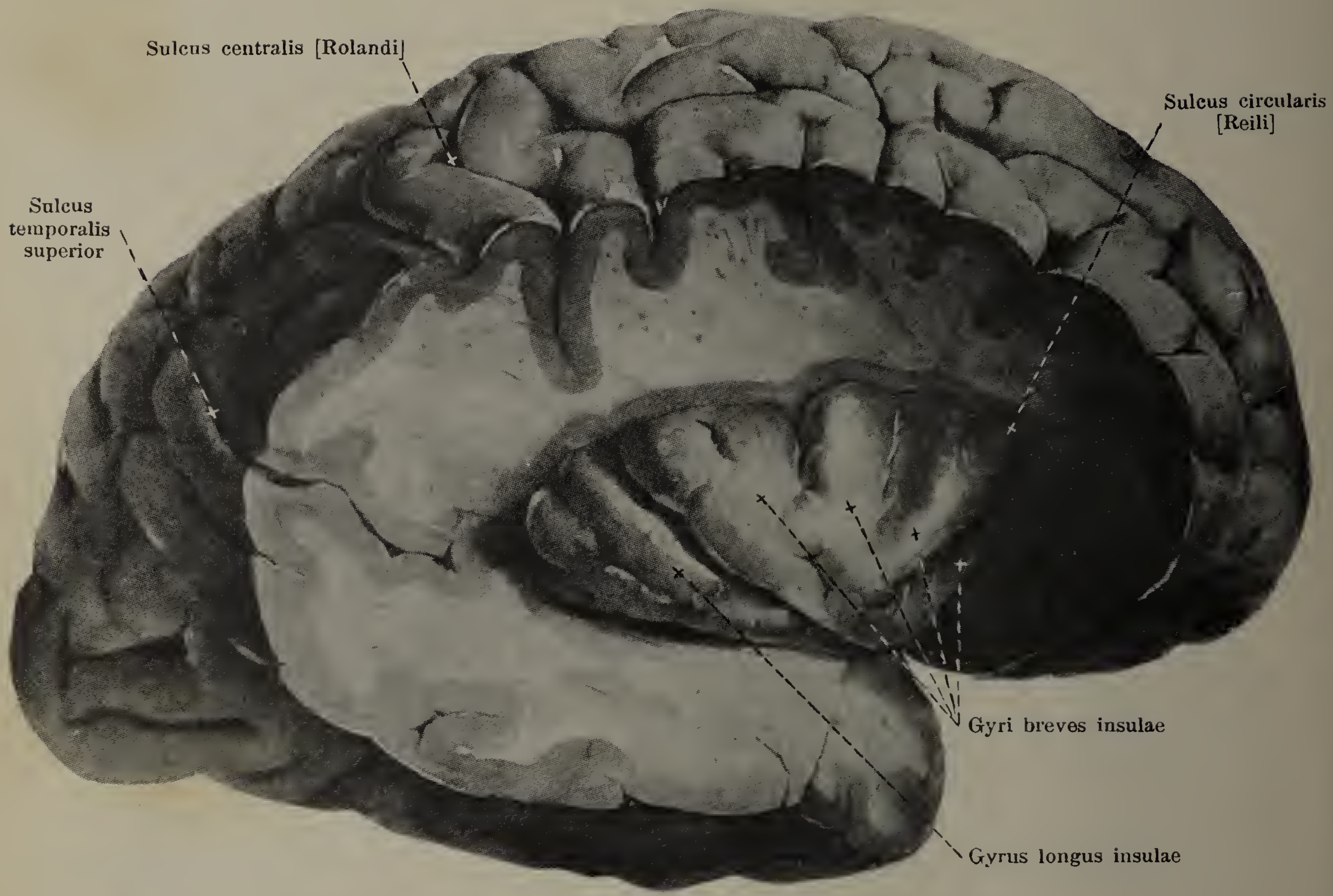
Pallium (continued).

Behind the gyrus centralis anterior, the *sulcus centralis [Rolandi]* (O. T. fissure of Rolando) (see Figs. 759—764) passes obliquely upward and backward, usually as far as the medial surface. On the inferior, basal surface, the *sulci orbitales* and the *sulcus olfactorius* are to be seen; they separate the *gyri orbitales* and the *gyrus rectus* from one another.



766. Base of the cerebrum *(basis cerebri),*
viewed from below, partly schematic. (See text to Fig. 765.)

Pallium (continued) (see also Figs. 759—765). In the parietal lobe, on the convex surface, the *gyrus centralis posterior* is bounded behind by the *sulcus interparietalis*, which also separates the *lobulus parietalis superior* from the *lobulus parietalis inferior;* in the latter, the curved gyrus surrounding the end of the fissura cerebri lateralis is called the *gyrus supramarginalis,* and the gyrus encompassing the end of the sulcus temporalis superior, the *gyrus angularis.* The *occipital lobe* is divided, on its convex surface, by the *sulcus occipitalis transversus,* as well as by the *sulci occipitales anterior, laterales, superiores* into the *gyri occipitales laterales et superiores.* In the *temporal lobe,* the *sulci temporales transversi* (see Fig. 768) divide the surface, which is turned partly toward the island, into the *gyri temporales transversi:* on the convex and basal surfaces are to be seen the *sulci temporales superior, medius* and *inferior,* situated beneath, or medianward from the *gyri temporales superior, medius* and *inferior;* next to the latter, on the basal surface, is the *gyrus fusiformis,* then the *fissura collateralis,* and then, behind, the *gyrus lingualis,* in front, the *gyrus hippocampi* (see below). On the *facies medialis hemisphaerii* (see Figs. 761 and 762) the *sulcus corporis callosi* runs just above the corpus callosum and goes over behind into the *fissura hippocampi,* which is situated between the gyrus hippocampi and the fascia dentata. Along these two sulci runs the *gyrus fornicatus,* which is divisible into an upper part, *gyrus cinguli,* a lower part, *gyrus hippocampi* with the *uncus [gyri hippocampi]* (see also Figs. 774 and 775 and p. 674), and an intermediate portion, *isthmus gyri fornicati.* By means of the rhinencephalon, which connects through the area parolfactoria with the gyrus cinguli (see also Fig. 749) and through the substantia perforata anterior with the gyrus hippocampi, the two ends of the gyrus fornicatus are united to form a closed ring. The gyrus cinguli is bounded by the *sulcus cinguli,* which in its *pars subfrontalis* belongs to the anterior inferior part of the frontal lobe, and in its *pars marginalis* turns up behind the medial end of the sulcus centralis to the convex surface of the hemisphere


Sulcus centralis [Rolandi]
Sulcus circularis [Reili]
Sulcus temporalis superior
Gyri breves insulae
Gyrus longus insulae

767. **Right island, exposed,** viewed from the right.

(The parts of the frontal, parietal, and temporal lobes covering the island, *i. e.* the operculum, have been removed by a cone-like section. See also Fig. 759.)

Pallium (continued). Following upon the sulcus cinguli (see Figs. 761 and 762) can be seen, in front, the gyrus frontalis superior and behind it, as far as the ramus marginalis of the sulcus cinguli, the ***lobulus paracentralis;*** behind this, again, lies the ***praecuneus,*** which is bounded below by the ***sulcus subparietalis,*** and behind by the ***fissura parietooccipitalis;*** behind this fissure, extending as far as the ***fissura calcarina,*** is the ***cuneus.***

If the margins of the fissura cerebri lateralis [Sylvii] (see p. 661) be drawn apart, a deep fossa becomes visible, the *fossa cerebri lateralis [Sylvii];* its floor is formed by a special lobe of the cerebral hemisphere, the ***island (insula)*** (see also Figs. 768 and 769). During embryonic life this is exposed, but later it becomes overlapped in front and above by part of the frontal lobe, behind and above by a part of the parietal lobe, and below by a part of the temporal lobe. These parts of the hemisphere, which hide the island completely, are spoken of, together as the *operculum (lid);* it is divisible into a *pars frontalis*, a *pars parietalis* and a *pars temporalis.* The surface of the island is convex lateralward; it is divided by a crest, gradually rising from behind forward, into an upper lateral, a lower lateral and an anterior surface; a narrow, inferior surface (see Fig. 749) lies approximately horizontal and goes over medianward into the limen insulae (see p. 665). At the junction of the surface of the island with that of the operculum, running between the two, is a slit-like groove, ***sulcus circularis [Reili];*** it is lacking only at the limen insulae. On the surface of the island are a number of gyri, ***gyri insulae.*** A deep sulcus running from in front and below, backward and upward, separates a larger, anterior portion of the island from a smaller, posterior portion; in the anterior portion several ***gyri breves insulae*** can be seen diverging from the apex of the crest; in the posterior, there is a simple, long, arched gyrus, ***gyrus longus insulae.***

The ***rhinencephalon*** *(olfactory brain)* (see Figs. 744—749, 761 and 762) is relatively feebly developed in human beings. It belongs chiefly to the base of the brain, but in part helps also to form the medial surface of the cerebrum, where it is separated, by a short, curved sulcus, ***sulcus parolfactorius anterior*** (see Figs. 748, 761 and 762), from the gyrus frontalis superior and the gyrus cinguli. On embryological grounds a *pars anterior [rhinencephali]* and a *pars posterior [rhinencephali]* can be distinguished.

The pars anterior rhinencephali (see Figs. 749, 758, 765 and 766) at the base of the brain, is formed by the *lobus olfactorius (olfactory lobe)* which, on each side, on the inferior surface of the frontal lobe passes backward and somewhat lateralward to the brain-stem; at its largest anterior part it lies very close to the sulcus olfactorius. It presents, in front. an oval, gray enlargement, *bulbus olfactorius*, which lies upon the lamina cribrosa of the ethmoid bone, and into which the nn. olfactorii enter; connected with the bulb is a whitish, triangular, prismatic band, *tractus olfactorius*, which broadens somewhat behind and goes over into a gray ridge, running transversely and at right angles to it, the *trigonum olfactorium* (see Fig. 749). This is sharply marked off behind from the substantia perforata anterior and presents on its inferior surface three whitish bands of fibres which begin at the tractus and disappear at the anterior boundary of the substantia perforata anterior: the *stria lateralis*, the longest, passes in a curve backward and lateral, the *stria medialis* goes backward and somewhat medial, while the *stria intermedia*, occasionally present between these two, runs almost straight backward. Running out lateralward and somewhat backward from the trigonum, along the substantia perforata anterior, to the gyrus hippocampi is a gyrus which is directly connected lateralward with the island (see p. 664) and is therefore called in that situation the *limen insulae (threshold of the island)*. Medianward, the trigonum goes over into a gyrus, the *area parolfactoria [Brocae]* (see Figs. 748, 749, 761 and 762), which belongs to the medial surface of the cerebrum; it is bounded in front by the sulcus parolfactorius anterior (see p. 664) and is separated behind from the gyrus subcallosus by the deep *sulcus parolfactorius posterior.*

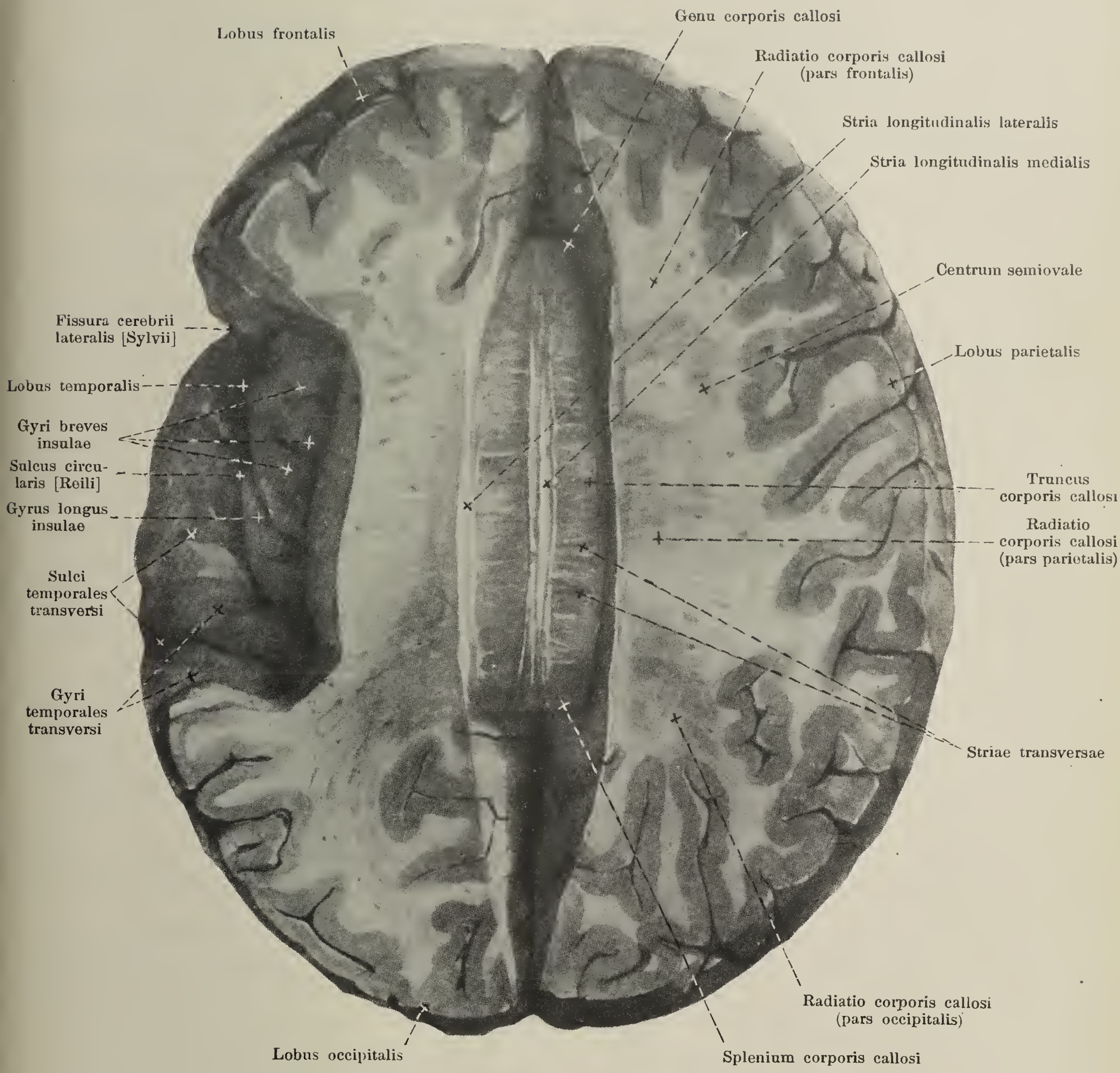
The pars posterior rhinencephali includes, at the base of the brain, the *substantia perforata anterior* (see Fig. 749), thus named on account of the numerous perforations in it, in front particularly, for blood vessels, lies directly behind the trigonum olfactorium; it is an approximately quadrangular, gray area; laterally it adjoins the uncus, medially and behind, the tractus opticus; medially and in front, it goes over into a whitish ridge, *gyrus subcallosus [pedunculus corporis callosi]*, which passes above the chiasma opticum to the medial surface of the cerebrum, runs upward in front of the commissura anterior and the lamina rostralis (see Figs. 748, 749, 761 and 762) and, tapering out, becomes fused with the rostrum corporis callosi (see also p. 668).

The other portions of the brain, situated at the base in front of the substantia perforata posterior (see Figs. 744—748, 749, 758 and 765), belong to the ***hypothalamus.*** In it, two parts are to be distinguished; its posterior part, *pars mamillaris*, which is formed by the corpora mamillaria, belongs to the diencephalon; its anterior part, *pars optica*, which includes the other parts, belongs to the telencephalon. Just in front of the substantia perforata posterior (see p. 656) project the *corpora mamillaria*, two white, pear-shaped elevations which are crowded close against one another at their thick, medial extremities. In front of them rises an unpaired, gray hillok, *tuber cinerum*, which, in front, tapers off like a cone to form the *infundibulum (funnel)* (see Figs. 748 and 765). Hanging on the latter, as though on a stem, is an egg-shaped gray mass, about the size of a bean, the *hypophysis (pituitary body)* (see Figs. 748 and 758), the largest diameter of which is placed frontally. It is situated in the fossa hypophyseos of the sella turcica, and on section is seen to consist of two parts, a larger anterior, *lobus anterior*, which embryologically, does not belong to the brain (it is developed from the Rathke's pouch of the primitive oral cavity), but only lies in contact with it, and a smaller posterior, *lobus posterior*, which alone is directly continuous with the infundibulum; between both of these lies the small *intermediate lobe.* Directly attached to the tuber cinereum in front and lateralward is the posterior margin of the unpaired *chiasma opticum*, a white, thick, quadrangular plate, with concave margins, situated somewhat behind the sulcus chiasmatis of the sphenoid bone; at its two anterior corners, it receives the nn. optici; from its two posterior corners go off the two *tractus optici.* Passing upward from the upper anterior surface of the chiasm, is a thin layer, *lamina terminalis* (see Figs. 748 and 749), which is in contact above with the anterior surface of the commissura anterior [cerebri] and then goes over into the lamina rostralis; it forms a part of the anterior wall of the third ventricle.

The *tractus opticus* (see Figs. 749, 750, 758 and 765), a flattened band fused with the subjacent tissue, runs at the posterior margin of the lamina perforata anterior, at first along the tuber cinereum; turning then lateralward and backward approximately at right angle to the direction of the pedunculus cerebri, it goes around the latter in the form of an arch, adjoining the gyrus hippocampi lateralward and below, and finally divides into two limbs which form the transition to the ***metathalamus*** (see p. 646). The narrower, medial limb, *radix medialis*, passes into the gray *corpus geniculatum mediale (medial geniculate body)* (see Figs. 750 and 757), an oblong, oval enlargement, situated at the anterior end of the sulcus lateralis mesencephali and of the brachium quadrigeminum inferius (see p. 655), bounded medianward by the brachium quadrigeminum superius as well as by the overhanging pulvinar and separated by a deep groove from the corpus geniculatum laterale. The thicker and shorter, lateral limb, *radix lateralis*, passes to the grayish-white *corpus geniculatum laterale (lateral geniculate* *body)*, an oblong body projecting only a little from the posterior inferior surface of the thalamus, lateral from the pulvinar.

Just in front of the geniculate bodies and corpora quadrigemina, on each side, lies the ***thalamus*** (see Figs. 748, 750, 757, 770, 773, 798 and 801), which first becomes visible after removal of the corpus callosum, fornix and choroid plexus. It is a large ganglionic mass of approximately oval shape, broadening behind. Only its upper and medial surfaces are free, its lateral and its narrow, inferior surfaces are fused with neighboring parts. The upper approximately triangular surface, covered by a layer of white matter *(stratum zonale)*, lies approximately horizontally and is curved so as to be slightly convex in the frontal direction, markedly convex in the sagittal direction. In front it presents an oval enlargement, *tuberculum anterius thalami;* behind it goes over into a ridge, protruding dorsalward, the medial portion of which, the *pulvinar*, projects for a greater or less distance over the superior quadrigeminal arm and the medial geniculate body, and the lateral portion of which contains the lateral geniculate body (see p. 665). The medial gray surface forms approximately a right angle with the superior surface, is placed sagittally and separated from that of the opposite side only by the third ventricle; below, it is separated from the ventricular surface of the hypothalamus by a shallow groove, *sulcus hypothalamicus [Monroi]* (see Fig. 748), which runs, curved somewhat like the letter S, from the foramen interventriculare to the aditus ad aquaeductum cerebri. Stretching out between the two thalami, somewhat in front of their middle, is a gray bridge, *massa intermedia*, very variable in thickness and form. At the junction of the medial and superior surfaces, runs a band of white matter, *stria medullaris*, which is situated somewhat deeper behind than in front; this gradually broadens behind to form a nearly horizontal, triangular area, *trigonum habenulae*. The stria, at its sharpened margin, is directly continuous with the epithelial lamella, *lamina chorioidea epithelialis*, which covers the *tela chorioidea ventriculi tertii* (see p. 674) below, and which, on being removed at its attachment, leaves behind a fine jagged edge, *taenia thalami;* behind, the taenia, corresponding to the region of departure of the epithelial lamella (vide infra), turns to the upper surface of the habenula and of the corpus pineale to go over at the latter place into that of the opposite side. Running out medianward from the trigonum habenulae is a white band of fibres, *habenula* (see Fig. 770); in its anterior part, it is continuous with that of the opposite side, thus forming the *commissura habenularum;* behind, on the contrary, it goes over into the *corpus pineale* (O. T. pineal gland). The latter (see Figs. 748, 757 and 770) forms a grayish-red, flattened, „pine-cone"-shaped body, usually nodular on the surface and variable in size; it is narrowed somewhat in front and lies in the groove between the two superior colliculi. The pineal body, the habenula and the trigonum habenulae belong to the ***epithalamus*** (see p. 646).

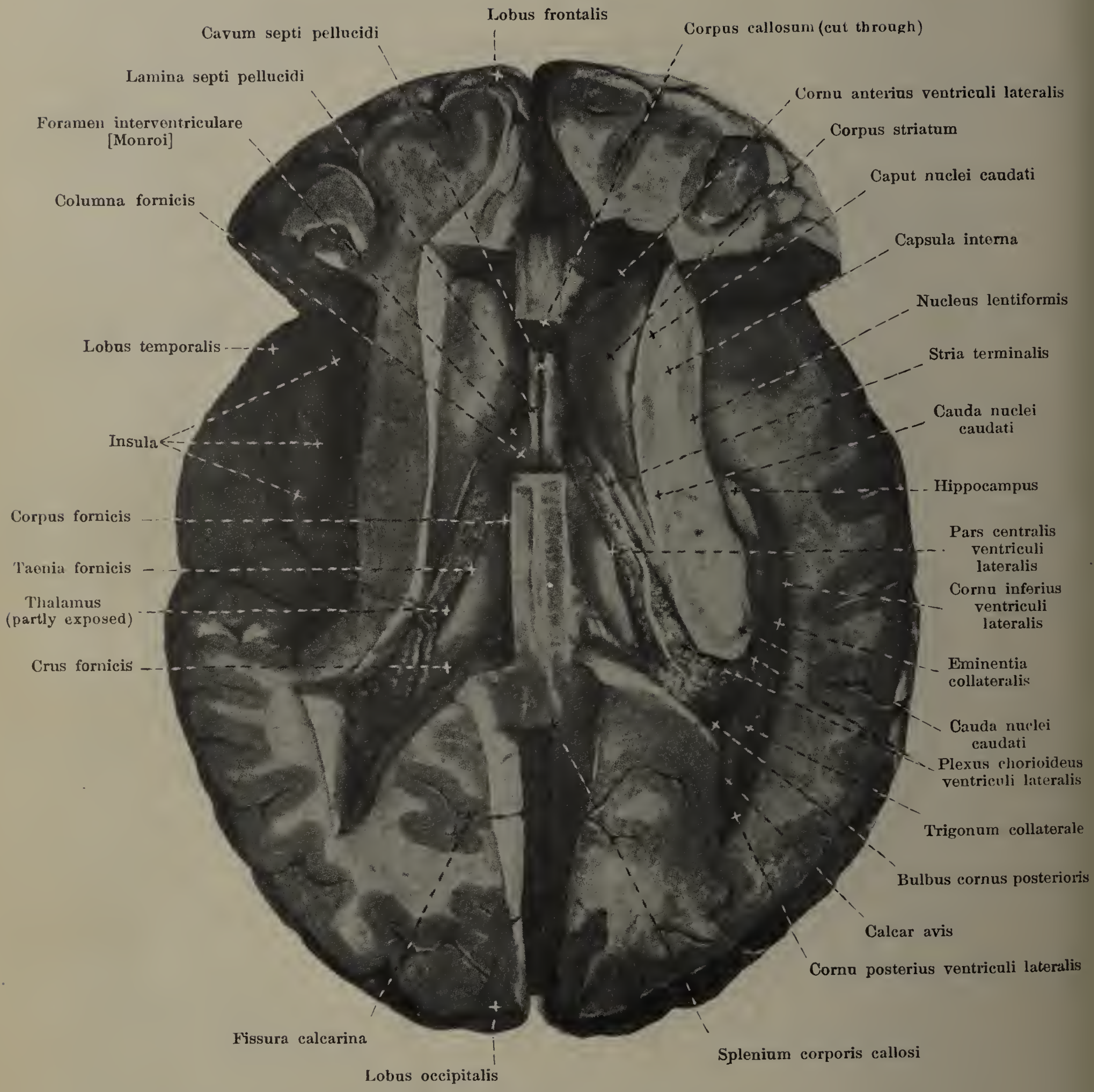
The ***third ventricle (ventriculus tertius)*** (see Figs. 748, 770, 773, 798 and 801) is an unpaired, median, slit-like space which is bounded on each side by the medial surface of the thalamus and of the hypothalamus; in that situation are to be seen the massa intermedia and the sulcus hypothalamicus (see above). The posterior wall is formed above by the corpus pineale, which is penetrated in front by a short slit, *recessus pinealis;* just beneath it runs the *commissura posterior [cerebri]*, a white band of fibres which bends around in a transverse direction and bulges into the cavity of the third ventricle; its fibres run partly caudalward to the tegmentum and to the fasciculus longitudinalis medialis, partly through the region of the thalamus lateralward, partly in an unknown direction. It bounds above the *aditus ad aquaeductum cerebri*, a three-sided funnel-shaped opening leading to the fourth ventricle. The narrow inferior wall is bounded behind by the diverging cerebral peduncles and presents two small elevations due to the corpora mamillaria; in front of them it is formed by the thin wall of the tuber cinereum; it becomes narrowed behind the chiasma opticum to form the funnel-like *recessus infundibuli*, from which a fine slit passes into the infundibulum. In front of the chiasma opticum, which projects into the cavity, is situated the *recessus opticus*, bounded in front by the thin *lamina terminalis*. This lamina forms the anterior wall; behind it above lies the *commissura anterior [cerebri]*, a thick band of white fibres which unites the two cerebral hemnispheres with one another and which is visible here, for a short distance, on the surface, but, otherwise, lies hidden in the substance of the brain. Lateral behind this commissure the columnae fornicis (see p. 670) form a part of the lateral wall of the ventricle and, converging, run upward; in this way, with the commissure, they surround the *recessus triangularis* (see Fig. 770). Above, the ventricle is closed by the *lamina chorioidea epithelialis* (vide supra) which is to be regarded as a thin portion of the brain wall, arrested in development. In front, on both sides, this is continued in its greatest extent through the taenia thalami into the stria medullaris, but it is fastened behind to the upper surface of the habenula and of the corpus pineale, and hence forms the upper boundary of the *recessus suprapinealis*, a blind-sac like cavity situated above the corpus pineale; in front it goes over into the posterior surface of the columna fornicis (see Fig. 748) and forms the upper boundary of the *foramen interventriculare [Monroi]*, which is bounded in front by the columnae fornicis, behind by the thalami, and connects the lateral ventricles with each other and with the third ventricle.


Lobus frontalis
Genu corporis callosi
Radiatio corporis callosi (pars frontalis)
Stria longitudinalis lateralis
Stria longitudinalis medialis
Centrum semiovale
Lobus parietalis
Fissura cerebrii lateralis [Sylvii]
Lobus temporalis
Gyri breves insulae
Sulcus circularis [Reili]
Gyrus longus insulae
Truncus corporis callosi
Radiatio corporis callosi (pars parietalis)
Sulci temporales transversi
Gyri temporales transversi
Striae transversae
Radiatio corporis callosi (pars occipitalis)
Lobus occipitalis
Splenium corporis callosi

768. Corpus callosum, exposed, viewed from above.

(The upper part of the cerebral hemispheres has been removed by a horizontal cut; small pieces in front and behind have been removed by wedge-shaped cuts. On the left side a portion of the hemisphere has been cut away to expose the island.)

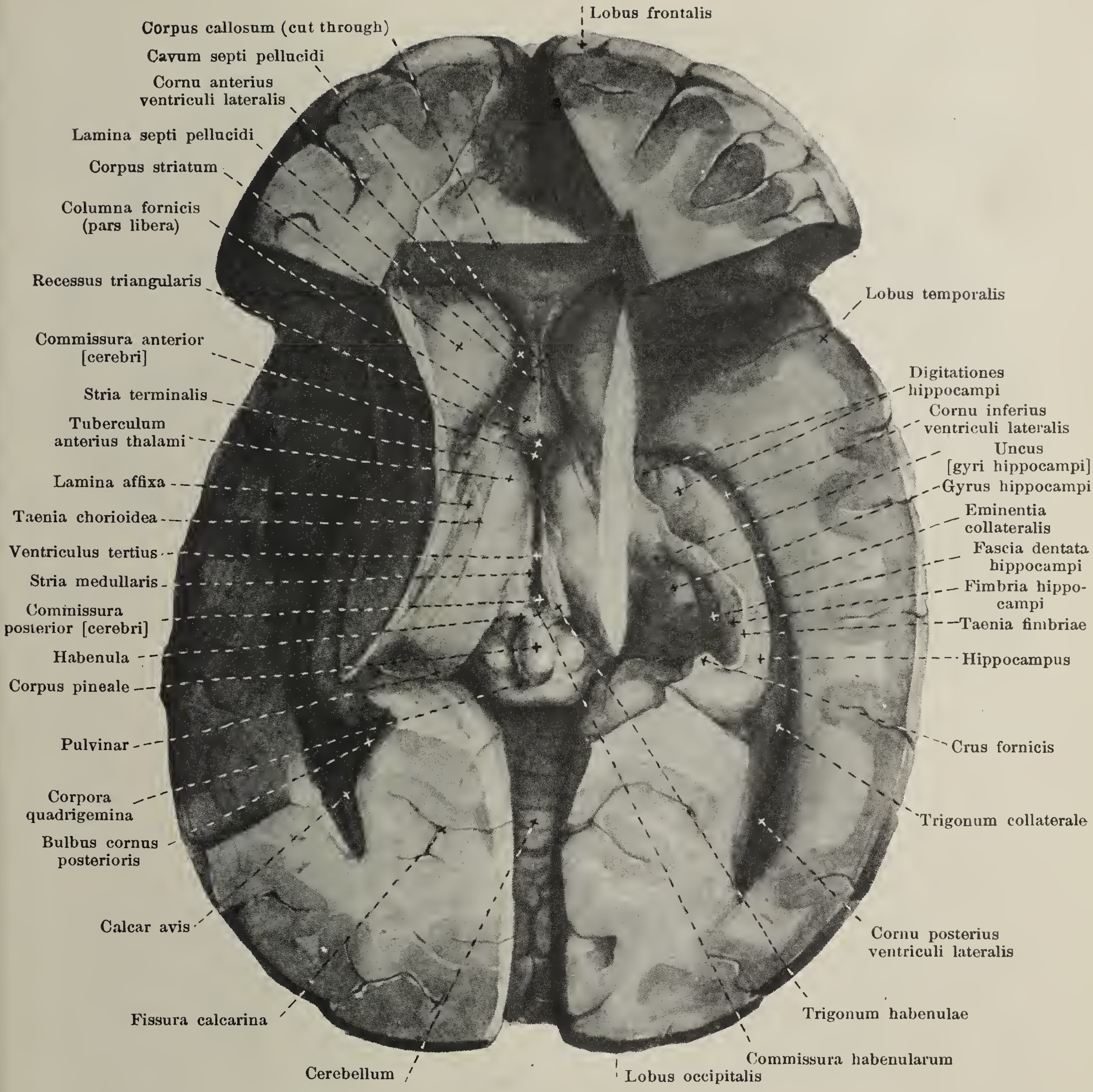
The ***corpus callosum*** (see also Figs. 748, 761, 769—773, 798 and 801) is a large mass of white fibres which unites the two cerebral hemispheres to each other. Only a smaller, medial portion of the mass lies free in the depth of the fissura longitudinalis cerebri; by far the larger part is concealed in the substance of the hemispheres into which it radiates. It begins in front of and above the commissura anterior (see Figs. 748 and 749), in direct contact with the lamina terminalis, by a short, thin layer, *lamina rostralis*, which runs, in a curve, upward and forward; it then thickens suddenly to form the *rostrum corporis callosi*, extends forward and then bends sharply backward, as the *genu corporis callosi*, to pass backward as the arched *truncus corporis callosi* until over the corpora quadrigemina, where it ends in a thickened margin, *splenium corporis callosi* (see also Fig. 765).



769. Lateral ventricle, opened, viewed from above.

(As in Fig. 768. In addition, the corpus callosum, with the exception of a narrow remnant, has been removed; besides, the posterior horn has been opened on both sides, and, on the right side, the inferior horn has been fully exposed by cutting away the island and the upper part of the temporal lobe.)

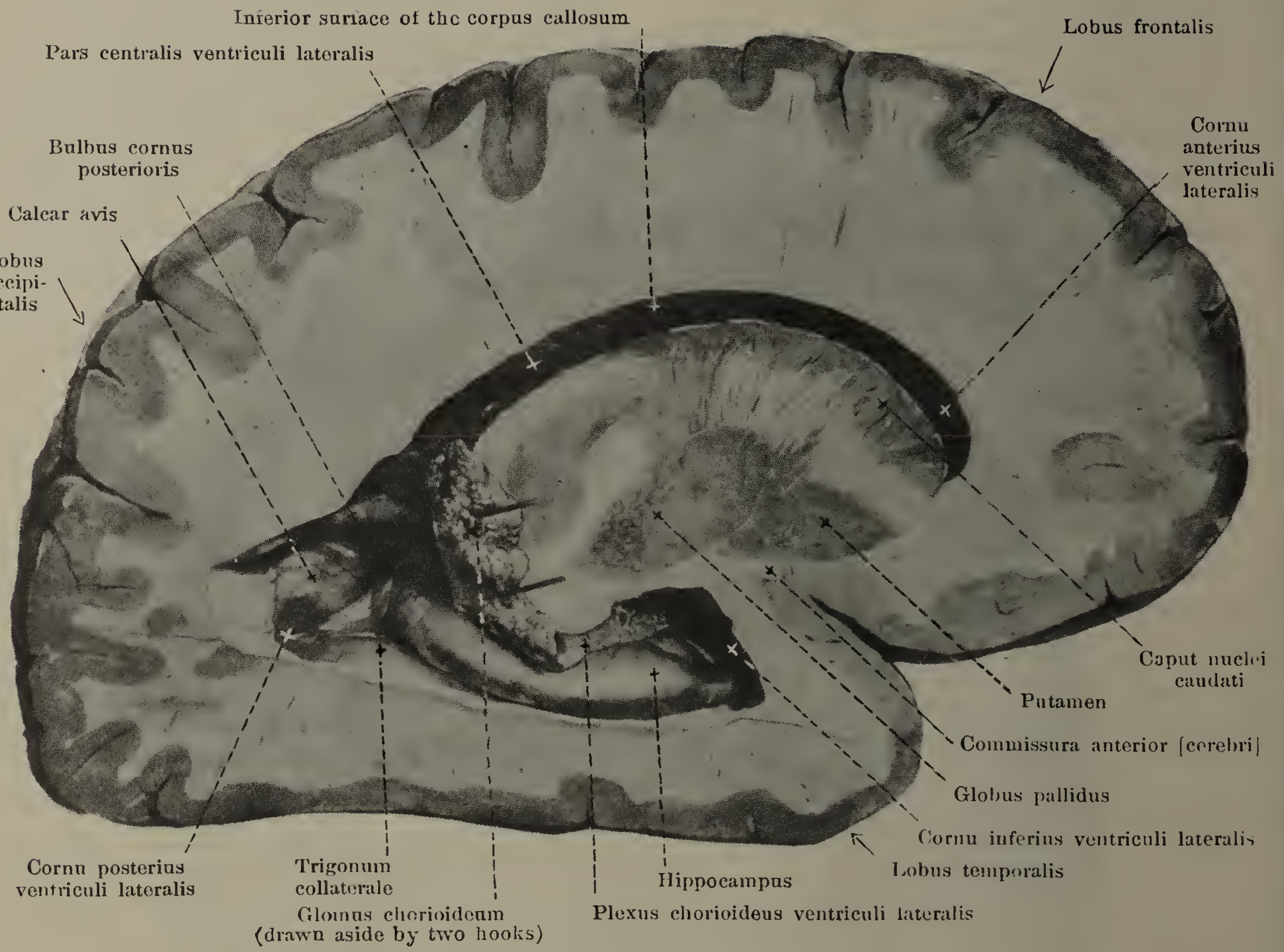
Corpus callosum (continued) (see also Figs. 768 and 773). The surface shows transverse bands, ***striae transversae***, due to the fibre bundles. In addition, a delicate, variable, longitudinal band, ***stria longitudinalis medialis,*** runs, on each side, close to the median plane. This bends around, in front, upon the rostrum and unites with the gyrus subcallosus; behind, it goes over into the *fasciola cinerea* (see Fig. 761), a strip of gray matter which lies directly in contact with the splenium corporis callosi, below and lateralward, and is continued, below and in front, partly into the fascia dentata hippocampi, partly runs pointed between the fascia dentata and the fimbria hippocampi. A second, still more delicate and more irregular longitudinal band, ***stria longitudinalis lateralis,*** lies lateralward on the surface of the corpus callosum, in the depth of the sulcus corporis callosi.



770. Third ventricle, opened, viewed from above.

(Same as in Fig. 769. In addition, the corpus callosum and a large part of the fornix have been removed. On the left side the inferior horn has been opened. On the right side more of the basal ganglia has been cut away, so as to expose completely the hippocampus and its neighborhood.)

Beneath the corpus callosum lies the ***fornix*** (see also Figs. 748, 761, 769, 773, 798, 799 and 801). It consists of two white strips, a right and a left one, often not entirely symmetrical, each being curved almost in the form of a spiral. These run separately in the most anterior part *(columnae fornicis)*, are closely approximated in their middle portion to the unpaired *corpus fornicis*, which is joined above to the under surface of the corpus callosum; behind they again become separated *(crura fornicis)*, and as they diverge, they pass to the inferior horns of the lateral ventricles, there becoming continuous in the main with the *fimbria hippocampi* (see p. 674). In the triangular space, bounded by the lamina rostralis, rostrum, genu and truncus corporis callosi on the one side, and by the uppermost part of the columnae and of the corpus fornicis on the other side (see Figs. 748 and 761), the *septum pellucidum* is stretched out as a partition between the anterior cornua of the lateral ventricles; it consists (see also Figs. 769, 799 and 800) of two thin layers, *laminae septi pellucidi*, which enclose a narrow, median slit, *cavum septi pellucidi*, closed on all sides.

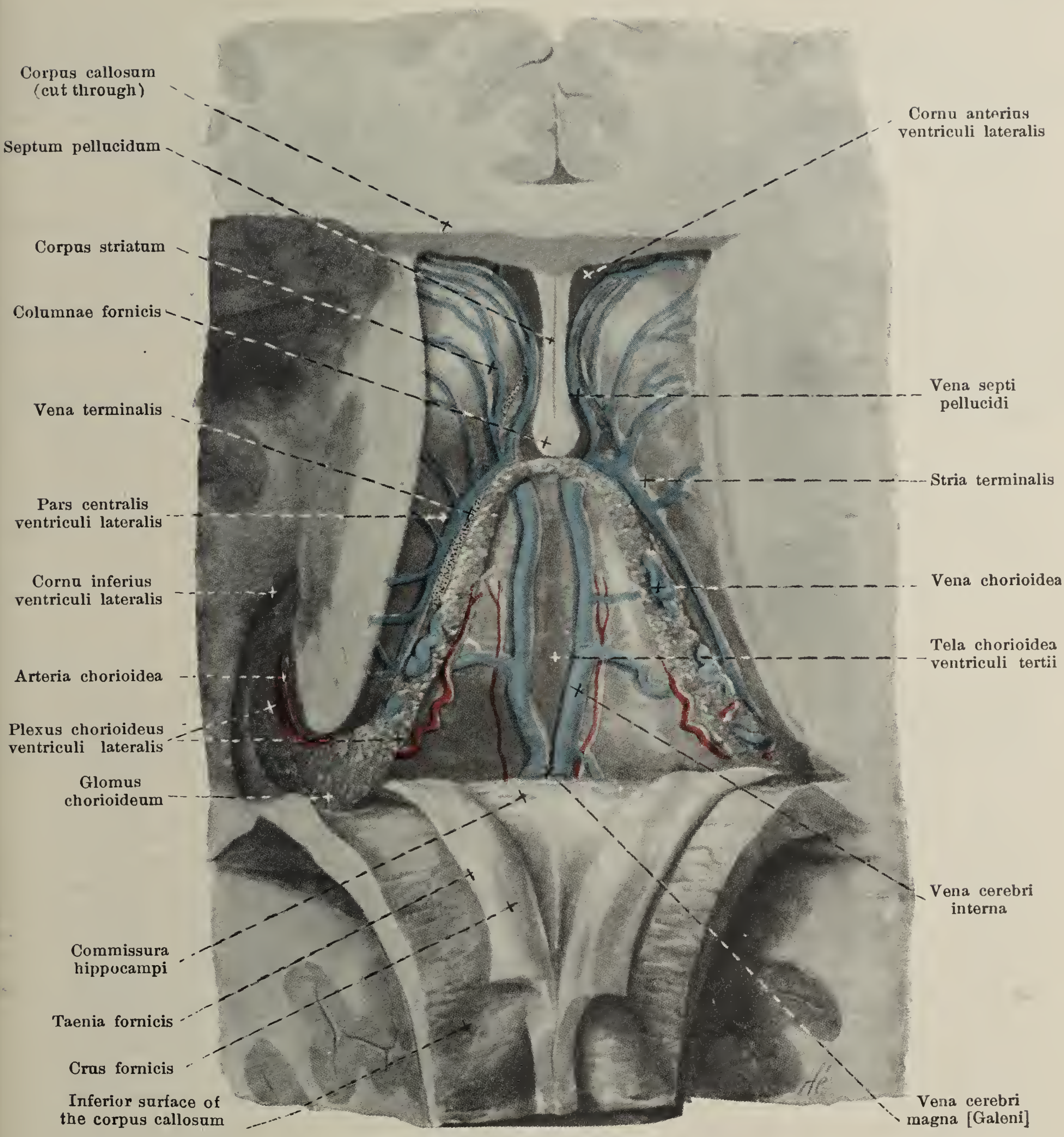

Inferior surface of the corpus callosum
Pars centralis ventriculi lateralis
Lobus frontalis
Bulbus cornus posterioris
Cornu anterius ventriculi lateralis
Calcar avis
Lobus occipitalis
Caput nuclei caudati
Putamen
Commissura anterior [cerebri]
Globus pallidus
Cornu inferius ventriculi lateralis
Cornu posterius ventriculi lateralis
Trigonum collaterale
Hippocampus
Lobus temporalis
Glomus chorioideum (drawn aside by two hooks)
Plexus chorioideus ventriculi lateralis

771. Right lateral ventricle, opened, viewed from the right.

(The largest part of the right hemisphere has been removed by two approximately sagittal cuts.)

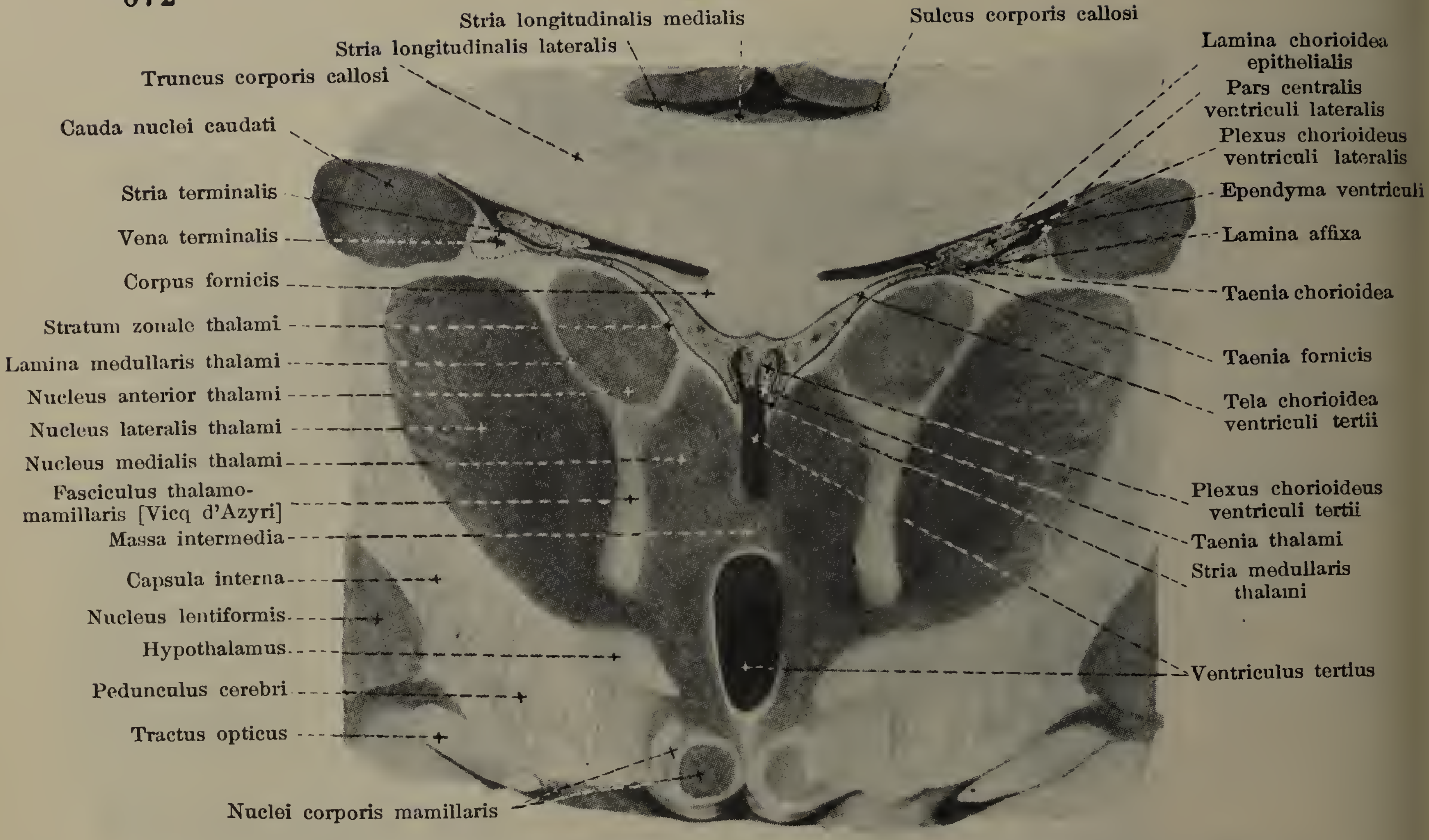
Fornix (continued) (see Figs. 748, 761, 769, 770, 773, 798, 799 and 801). The *columna fornicis* (bilateral) is a cylindrical bundle of medullated fibres; hidden in the hypothalamus it extends forward and upward from the corpus mamillare as the *pars tecta columnae fornicis*, emerges in part from the lateral wall of the 3rd ventricle just behind the commissura anterior and runs upward and somewhat medianward as the *pars libera columnae fornicis*, soon fusing completely with its fellow of the opposite side; the pars libera forms the anterior boundary of the foramen interventriculare [Monroi] (see p. 666). The *corpus fornicis* reaches from the region of the foramen interventriculare backward and somewhat upward as far as the middle of the thalamus; in this course it is separated from the roof of the 3rd ventricle and from the upper surfaces of the thalami by the tela chorioidea ventriculi tertii. It is fused behind with the inferior surface of the corpus callosum; in front it is united with that body by the septum pellucidum. The inferior surface presents a groove-like depression in the middle. Each half is rather rounded in cross-section in front, more triangular behind, and is drawn out laterally into a fine edge, *taenia fornicis,* from which the lamina epithelialis of the plexus chorioideus ventriculi lateralis extends out; the two taeniae fornicis become continuous with each other in front, over the foramen interventriculare. The *crus fornicis* is markedly flattened and directly attached to the inferior surface of the corpus callosum; it runs obliquely backward, lateralward and downward on each side, over the pulvinar, to the inferior horn (see p. 669). The two crura fornicis bound a triangular area, which is closed behind by the splenium corporis callosi, and the floor of which is formed by the inferior surface of the corpus callosum (see Fig. 772); the transverse fibres visible in this area form the *commissura hippocampi.*

The ***ventriculus lateralis (lateral ventricle)*** (see also Figs. 769 and 772—774) is the paired cavity which is situated symmetrically within each cerebral hemisphere; it is connected by the foramen interventriculare [Monroi] with the 3rd ventricle and through this indirectly also with the lateral ventricle of the other side, but is otherwise completely closed; it contains a small amount of liquor cerebrospinalis.


Corpus callosum (cut through)
Septum pellucidum
Corpus striatum
Columnae fornicis
Vena terminalis
Pars centralis ventriculi lateralis
Cornu inferius ventriculi lateralis
Arteria chorioidea
Plexus chorioideus ventriculi lateralis
Glomus chorioideum
Commissura hippocampi
Taenia fornicis
Crus fornicis
Inferior surface of the corpus callosum
Cornu anterius ventriculi lateralis
Vena septi pellucidi
Stria terminalis
Vena chorioidea
Tela chorioidea ventriculi tertii
Vena cerebri interna
Vena cerebri magna [Galeni]

772. Tela chorioidea ventriculi tertii, laid bare from above. (The specimen has been prepared in a similar way to that in Fig. 769, except that the corpus callosum, along with the fornix, has been cut through and reflected backward. The tela chorioidea ventriculi lateralis has been removed at the taenia fornicis.)

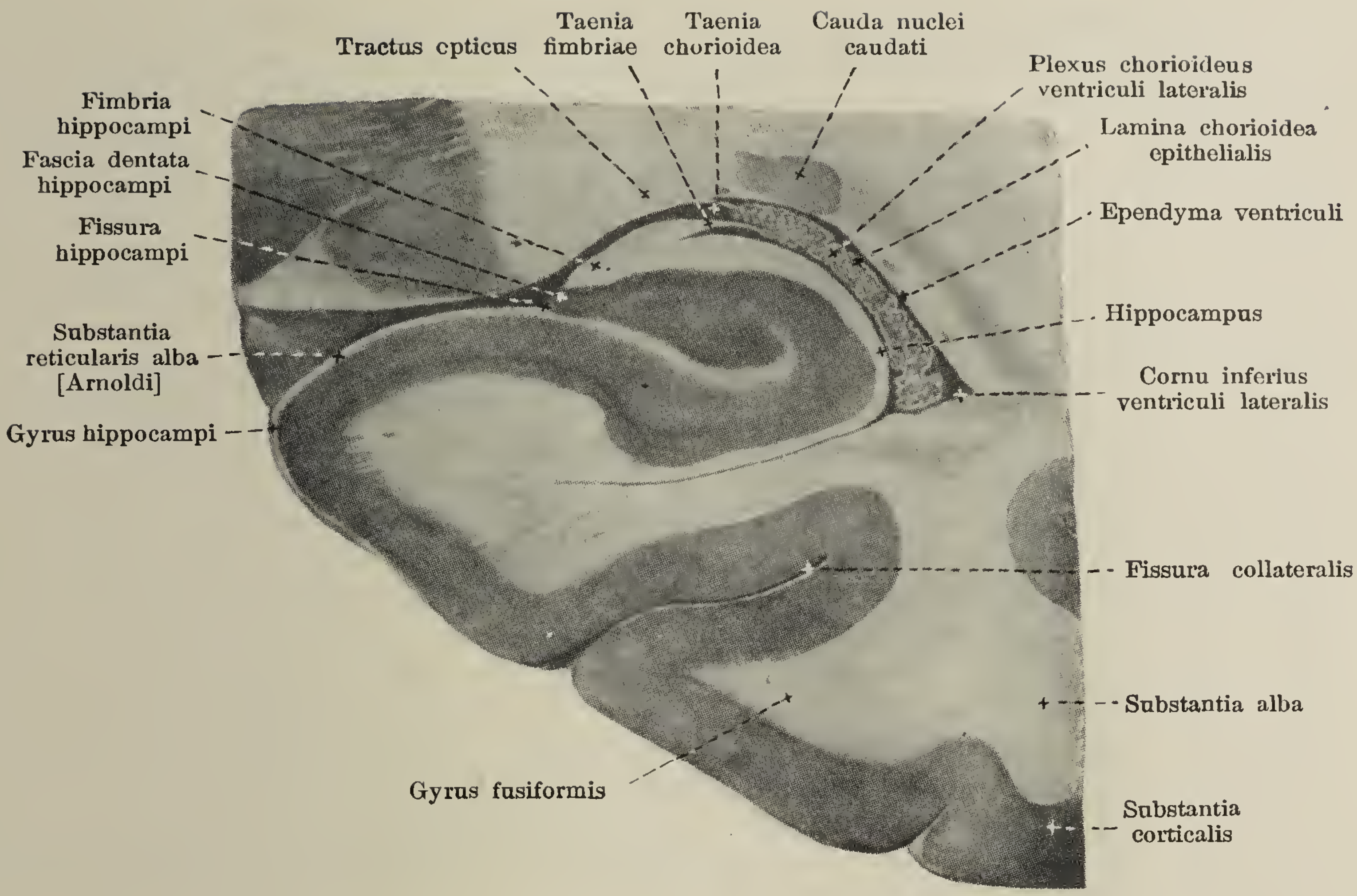
Ventriculus lateralis (continued) (see also Figs. 769, 771, 773 and 774). It resembles on each side, in the main, a horse-shoe, open in front (see Fig. 771), the upper end of which, *cornu anterius,* lies in the frontal lobe and the lower end of which, *cornu inferius,* lies in the temporal lobe; from the posterior convexity, a short process, *cornu posterius,* projects into the occipital lobe; the part between the foramen interventriculare and the cornu posterius is called the *pars centralis.* The lateral ventricle is partly bounded by the gray *corpus striatum (striate body)* (see p. 690), of which the anterior, flask-like, thickened end forms the lateral inferior wall of the cornu anterius; by means of its long, narrow, posterior part it extends through the pars centralis and, thence, markedly curved, into the roof of the cornu inferius. This free surface belongs to that part of the corpus striatum, known as *nucleus caudatus (tailed nucleus)* and has a corresponding form; its anterior portion is called *caput nuclei caudati,* its posterior and lower portion, *cauda nuclei caudati.*



773. Frontal section through the middle of the third ventricle. Magnification: 2:1. (The relations of the chorioid plexus are somewhat schematically represented; the origin of the lamina affixa is indicated by the dotted lines.)

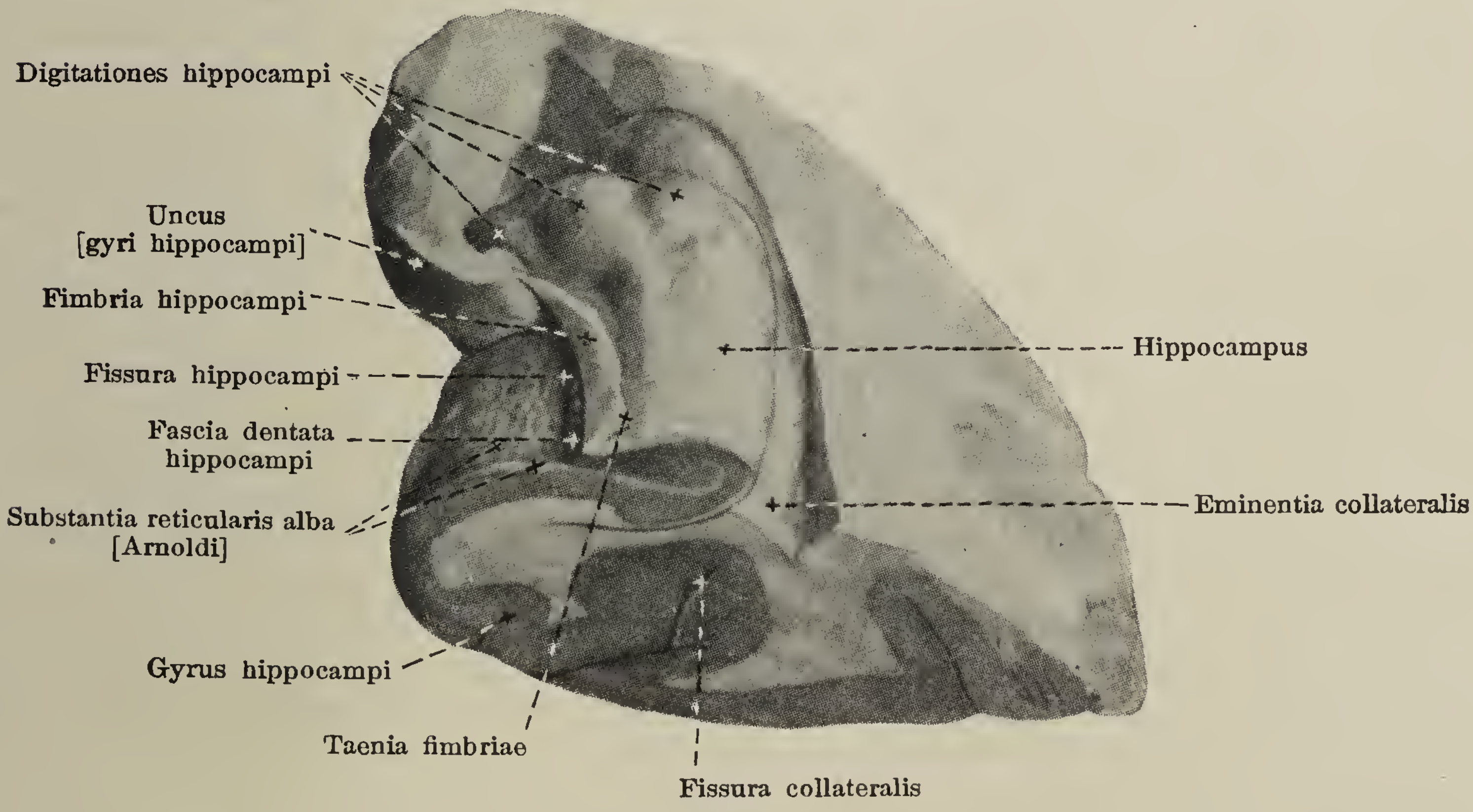
Ventriculus lateralis (continued) (see also Figs. 769, 771, 772 and 774). The anterior part of the nucleus caudatus rises above the thalamus in front; the middle part runs parallel to its lateral margin. In the latter situation, the ***stria terminalis*** (O. T. taenia semicircularis) runs on the surface between the two, from the region of the foramen interventriculare as far as the inferior horn; it contains a band of medullated fibres and is colored bluish by the v. terminalis which partly covers it. The layer of substance which covers the v. terminalis is continued as a thin layer, *lamina affixa* (see also Figs. 757 and 770), upon the neighboring part of the thalamus and is originally not fused to the thalamus, so that the v. terminalis runs extraventricularly; but it fuses already in the embryo with the thalamus; it at first increases in breadth from before backward, but further on decreases; it is absent in the inferior horn. It is directly continuous with the epithelium of the plexus chorioideus ventriculi lateralis, i. e. the *lamina chorioidea epithelialis*, and on removal of the choroid plexus is seen to terminate in a delicate, torn margin, *taenia chorioidea;* the latter, in the inferior horn, runs directly medianward from the cauda nuclei caudati, is connected at its anterior end with the taenia fimbriae and at the foramen interventriculare with the taenia thalami.

The *cornu anterius (anterior horn)* (see also Figs. 798—801) resembles a part of the cavity of a bowl, convex forward, upward and medianward; the arch of the bowl is formed by the most anterior part of the corpus striatum (see also p. 671). Above in front, and below, it is bounded by the radiations of the knee of the corpus callosum, medianly by the septum pellucidum, laterally by the caput nuclei caudati. The *pars centralis* is an approximately horizontal slit, the roof of which is formed by the inferior surface of the truncus corporis callosi; its inferior surface (see also Fig. 769) is composed of the middle, narrow part of the nucleus caudatus, the stria terminalis, the lamina affixa, the lamina chorioidea epithelialis of the plexus chorioideus ventriculi lateralis, as well as the upper surface of the corpus and crura fornicis. The *cornu posterius (posterior horn)* is a curved slit of variable length, convex lateralward in the horizontal direction, which curves in a hook-like fashion around the deep fissura parietooccipitalis, so that its posterior extremity is turned medianward. Its lateral, superior, limiting surface is formed by that part of the radiation of the corpus callosum known as the *tapetum.* Two variable longitudinal ridges run out backward upon its medial surface from the end of the pars centralis (see Figs. 769—771 and 801). The inferior, thicker ridge, *calcar avis,* corresponds to the anterior part of the fissura calcarina, which here shoves the thin wall of the hemisphere into the ventricle. The superior, irregular ridge, *bulbus cornus posterioris,* is a thickening of the hemispheric wall and is formed by fibres of the corpus callosum.



774. Frontal section through the inferior horn of the right lateral ventricle, viewed from behind. Magnific.: 2 : 1.

(The choroid plexus is somewhat schematically represented.)

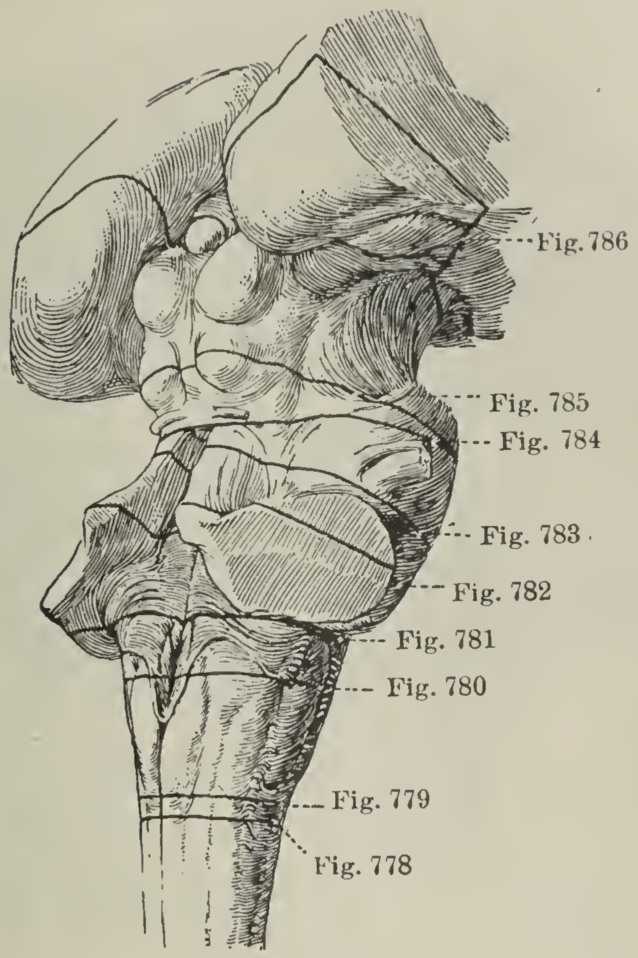


775. Inferior horn of the right lateral ventricle, anterior half, viewed from above and behind.

(The temporal lobe has been removed by a frontal section and the roof of the inferior horn afterwards cut away. See also Figs. 770, 771 and 774.)

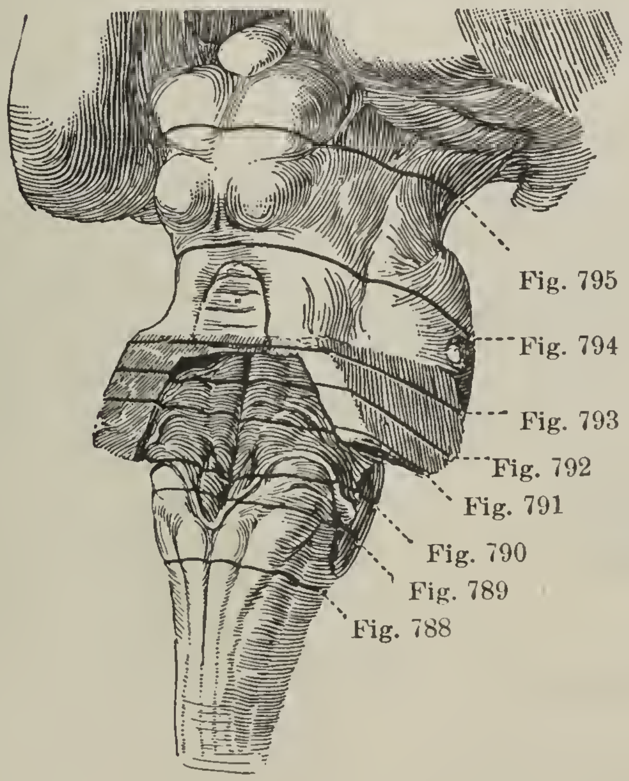
Ventriculus lateralis (continued) (see Figs. 769—775). The *cornu inferius (inferior horn)* is a curved slit which passes forward along the medial margin of the temporal lobe but does not reach its apex. Its narrow, inferior wall is developed behind from a feebly arched triangular area, *trigonum collaterale*, which is situated between the calcar avis and the hippocampus and extends also into the beginning of the posterior horn; it is sometimes elevated in the form of a longitudinal ridge *(eminentia collateralis)*, due to the bulging in of the wall of the hemisphere by the fissura collateralis. The lateral and superior wall is the immediate continuation of the similar surface of the posterior horn and is formed in the same way (see p. 672), but medianward it contains in addition the lowermost end of the cauda nuclei caudati. The medial wall is formed by a thick, white, longitudinal ridge, *hippocampus*, curved, like a sickle, which begins gradually behind at the end of the pars centralis and ends in front, expanded, in the uncus [gyri hippocampi]; its surface is divided, in front, by 2—4 flat, radial grooves, into a number of flattened elevations, *digitationes hippocampi*. The ridge corresponds to the fissura hippocampi and is caused by it. The white covering of the hippocampus is connected at its medial margin with the *fimbria hippocampi*, a triangular white strip which passes forward as far as the uncus and forms the direct continuation of the crus fornicis (see also Fig. 761). It goes over by a lateral, sharpened edge into the epithelium of the plexus chorioideus ventriculi lateralis and, when the choroid plexus is removed, ends in a delicate torn margin, *taenia fimbriae* (see p. 670). The largest part of the fimbria is situated outside of the ventricle and is separated from the fissura hippocampi and the gyrus hippocampi by a narrow, peculiarly notched strip of gray substance, *fascia dentata hippocampi*, which, in front, ends in the uncus and, behind, goes over into the fasciola cinerea (see p. 668). The part of the gyrus hippocampi adjoining this is covered by a delicate reticular layer of white substance, the ***substantia reticularis alba [Arnoldi]***, the relations of which are represented in Figs. 774 and 775.

The ***pia mater encephali*** (see p. 642) lies everywhere closely in contact with the external surface of the brain and penetrates also into the depths of the cerebral sulci. In addition it penetrates into the fissura cerebelli transversa, forming there the *tela chorioidea ventriculi quarti* (see p. 654). Farther. it passes into the fissura cerebri transversa as the *tela chorioidea ventriculi tertii* (O. T. velum interpositum) (see Figs. 748, 772 and 773). The latter is a triangular duplicature which ends blind, in front, at the foramen interventriculare. It consists 1. of an upper lamella which is attached to the inferior surface of the corpus callosum and of the fornix, 2. of an inferior lamella which covers the largest part of the superior surface of both thalami and in addition, covered by the lamina chorioidea epithelialis (p. 666), forms, between the two thalami, the roof of the third ventricle, and 3. of loose connective tissue, the continuation of the subarachnoidal connective tissue of the cisterna venae cerebri magnae (see p. 706). Within the latter, running from before backward, close to one another, are the two *venae cerebri internae* (see Fig. 772) which unite in the region of the corpus pineale to form the broad, unpaired *v. cerebri magna [Galeni]*. The latter passes around the splenium corporis callosi upward and to the front and runs from behind at an acute angle into the beginning of the sinus rectus (see Figs. 542 and 815). Each v. cerebri interna receives, in front, the *v. septi pellucidi*, which comes from the septum pellucidum, and the *v. terminalis*, which passes forward in the stria terminalis; one of these two receives the very tortuous *v. chorioidea*, which runs in the plexus chorioideus ventriculi lateralis. Hanging down, on each side, from the inferior lamella into the cavity of the third ventricle, very close to the median plane, is a narrow strip of lobulated, villus-like, reddish processes; those of the two sides together, are called the *plexus chorioideus ventriculi tertii (venous plexus of the third ventricle)* (see Fig. 773); they are covered by the lamina chorioidea epithelialis. A similarly constructed but thicker strip, *plexus chorioideus ventriculi lateralis (venous plexus of the lateral ventricle)* (see Figs. 769 and 771—774), penetrates on each side, between the fornix and fimbria on the one hand, and the stria terminalis on the other hand, into the pars centralis and into the cornu inferius of the lateral ventricle, being especially well developed at the junction between the pars centralis and the inferior horn where it is called the *glomus chorioideum;* the lamina chorioidea epithelialis, which covers it, proceeds from the taenia fornicis and from the taenia fimbriae to the taenia chorioidea. The two strips of the plexus chorioideus ventriculi tertii and the plexus chorioidei of the two lateral ventricles are connected with one another at the foramen interventriculare.



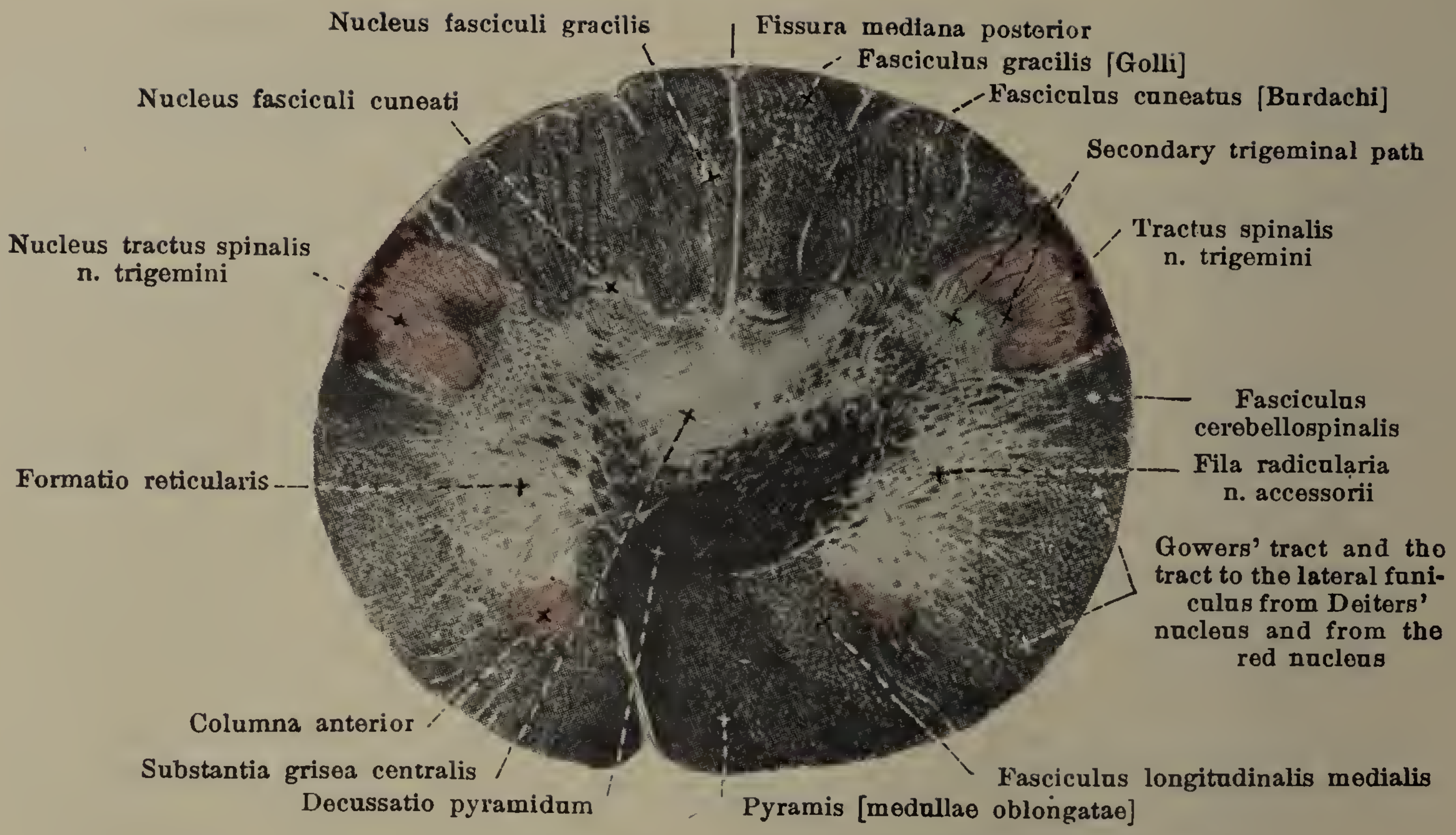
776. Brain-stem of an adult, viewed from behind and from the right and showing the directions of the sections represented in Figs. 778—786.

Magnification: 6:7.

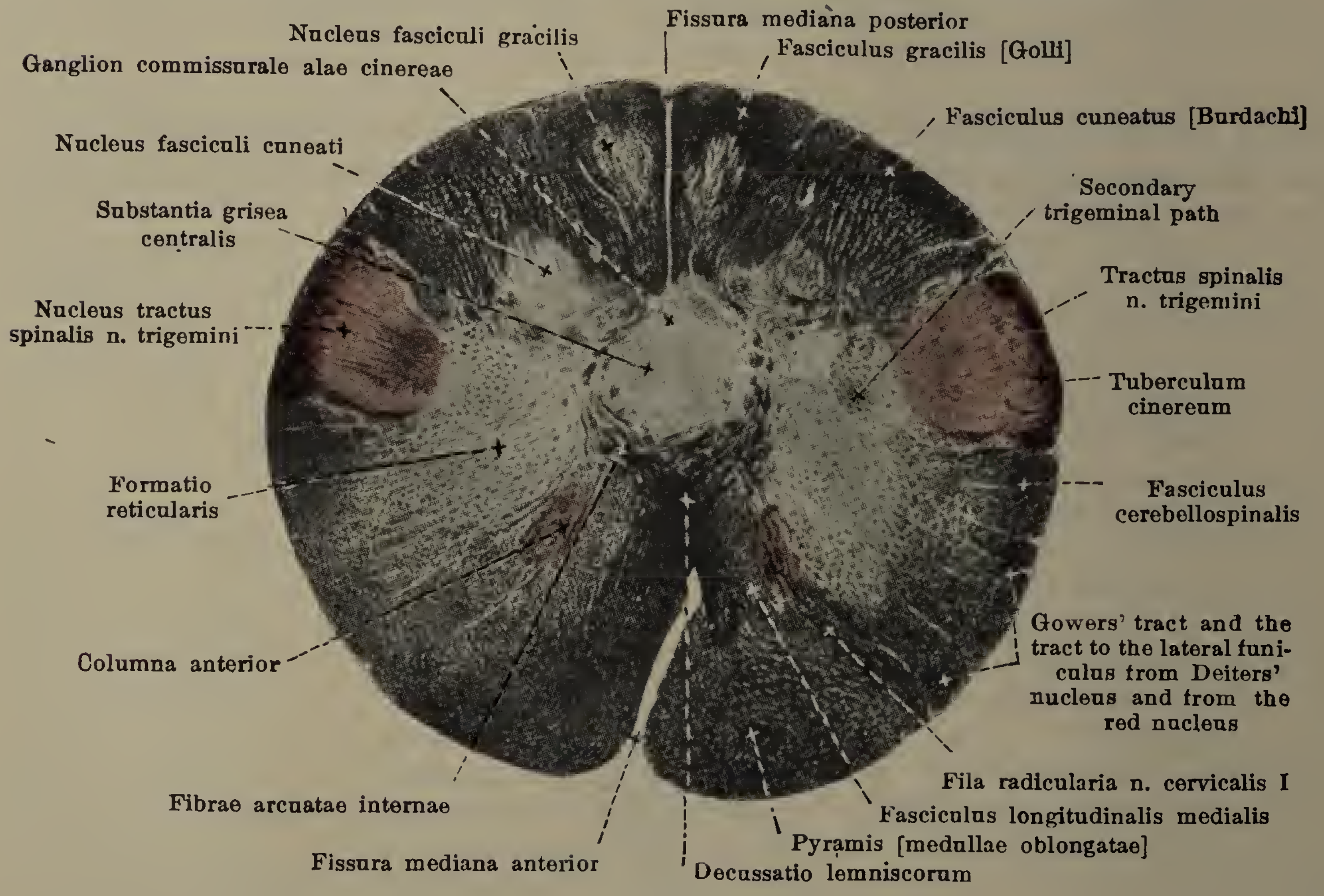


777. Brain-stem of an 8—9 month human fetus, viewed from behind and somewhat from the right, showing the direction of the sections represented in Figs. 788—795.

Magnification: 4:3.


Nucleus fasciculi gracilis
Fissura mediana posterior
Fasciculus gracilis [Golli]
Nucleus fasciculi cuneati
Fasciculus cuneatus [Burdachi]
Secondary trigeminal path
Nucleus tractus spinalis n. trigemini
Tractus spinalis n. trigemini
Fasciculus cerebellospinalis
Formatio reticularis
Fila radicularia n. accessorii
Gowers' tract and tho tract to the lateral funiculus from Deiters' nucleus and from the red nucleus
Columna anterior
Substantia grisea centralis
Fasciculus longitudinalis medialis
Decussatio pyramidum
Pyramis [medullae oblongatae]

778. Through the decussation of the pyramids. Magnification: 6:1.

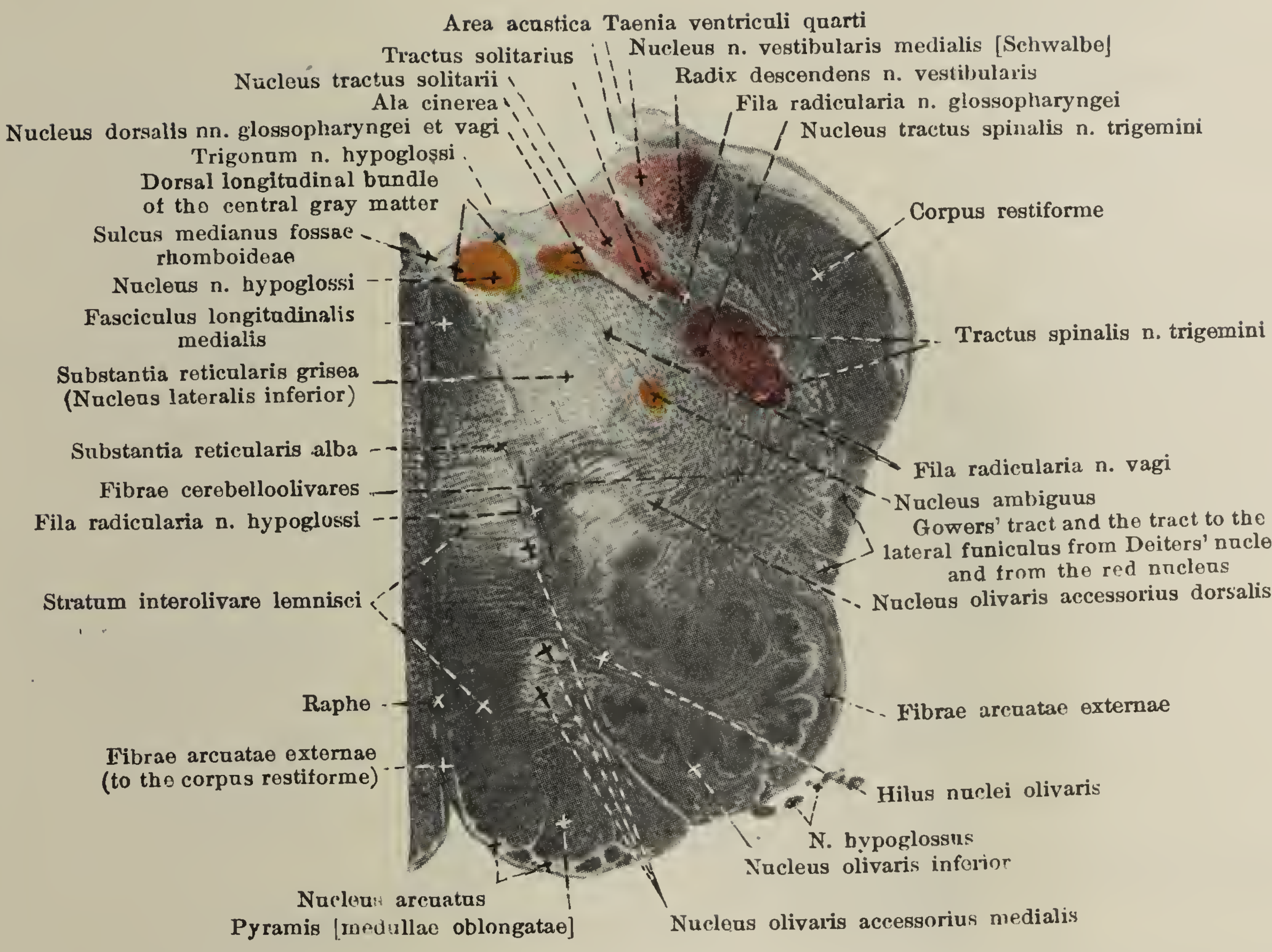

Fissura mediana posterior
Nucleus fasciculi gracilis
Fasciculus gracilis [Golli]
Ganglion commissurale alae cinereae
Fasciculus cuneatus [Burdachi]
Nucleus fasciculi cuneati
Secondary trigeminal path
Substantia grisea centralis
Tractus spinalis n. trigemini
Nucleus tractus spinalis n. trigemini
Tuberculum cinereum
Formatio reticularis
Fasciculus cerebellospinalis
Gowers' tract and the tract to the lateral funiculus from Deiters' nucleus and from the red nucleus
Columna anterior
Fila radicularia n. cervicalis I
Fibrae arcuatae internae
Fasciculus longitudinalis medialis
Pyramis [medullae oblongatae]
Fissura mediana anterior
Decussatio lemniscorum

779. Between the decussation of the pyramids and the olives. Magnification: 6:1.

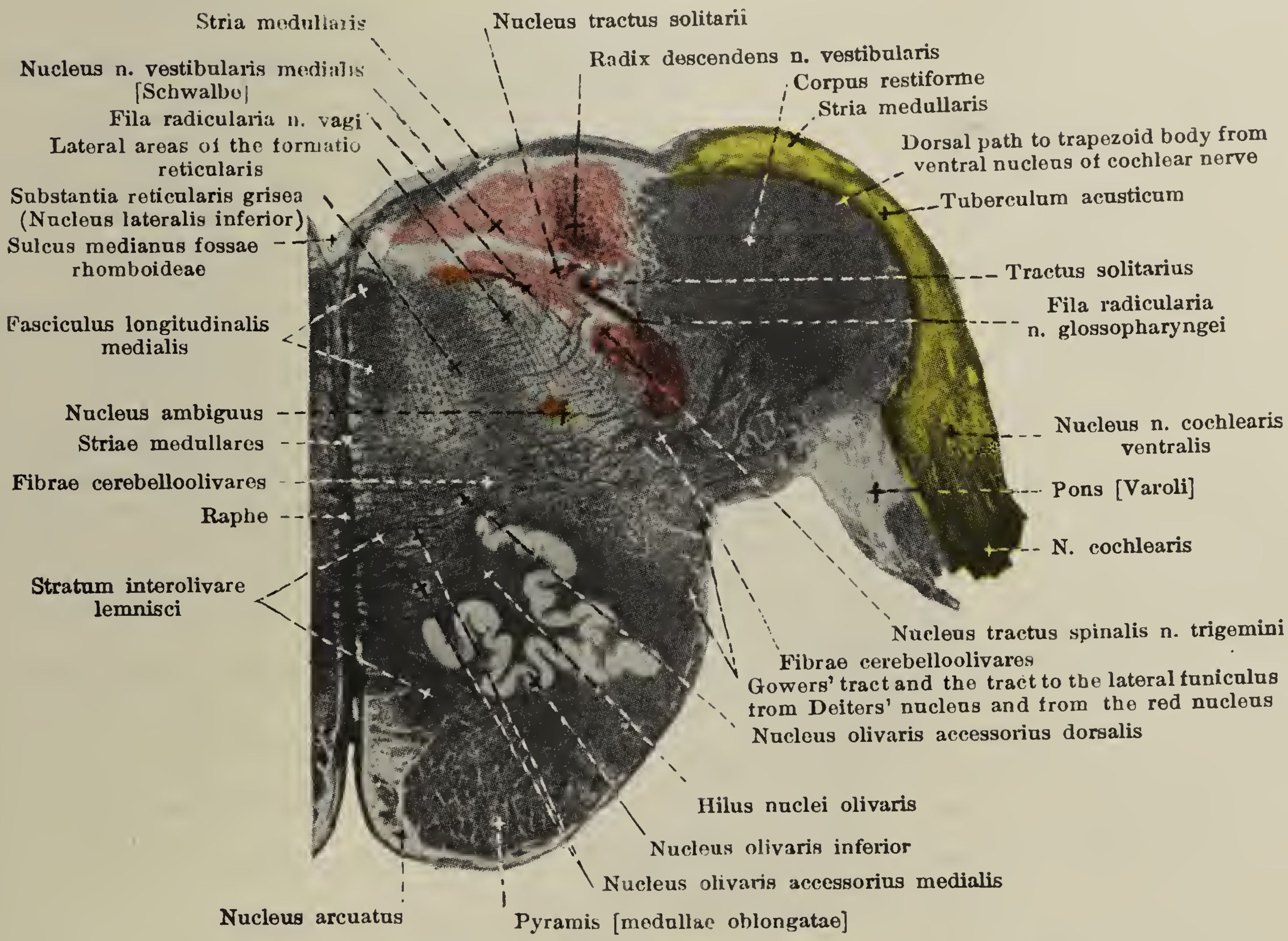
778—786. Transverse sections through the brain-stem of an adult. White substance black; gray substance light. Motor nuclei red. Sensory nuclei of termination colored violet (except the nuclei of the n. cochlearis which are colored yellow). (Held.)

Concerning the level and direction of the sections see Fig. 776.

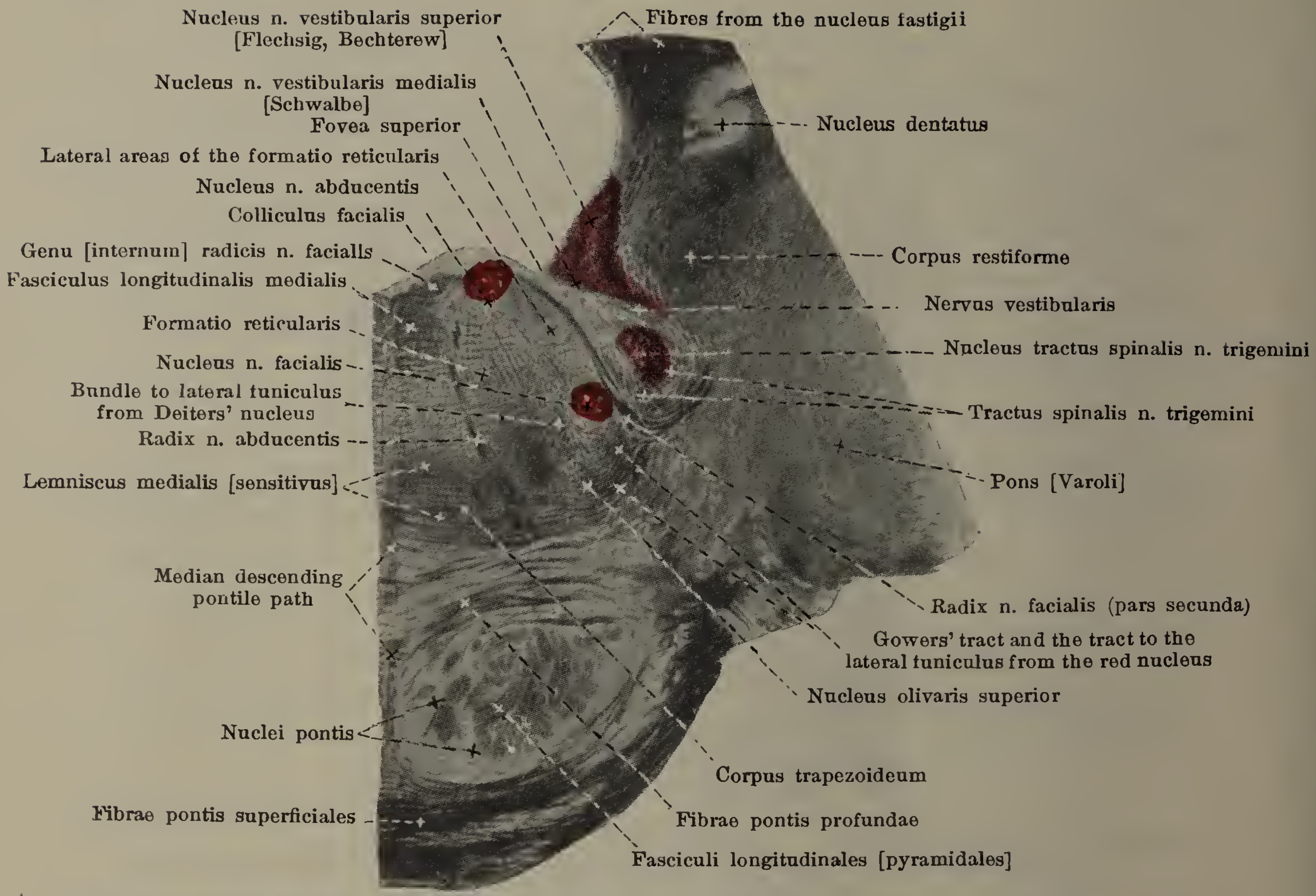
(The sections in Figs. 778—796 have been arranged so that their dorsal margins are upward.)


Area acustica
Taenia ventriculi quarti
Tractus solitarius
Nucleus n. vestibularis medialis [Schwalbe]
Nucleus tractus solitarii
Radix descendens n. vestibularis
Ala cinerea
Fila radicularia n. glossopharyngei
Nucleus dorsalis nn. glossopharyngei et vagi
Nucleus tractus spinalis n. trigemini
Trigonum n. hypoglossi
Dorsal longitudinal bundle of the central gray matter
Corpus restiforme
Sulcus medianus fossae rhomboideae
Nucleus n. hypoglossi
Fasciculus longitudinalis medialis
Tractus spinalis n. trigemini
Substantia reticularis grisea (Nucleus lateralis inferior)
Substantia reticularis alba
Fila radicularia n. vagi
Fibrae cerebelloolivares
Nucleus ambiguus
Fila radicularia n. hypoglossi
Gowers' tract and the tract to the lateral funiculus from Deiters' nucleus and from the red nucleus
Stratum interolivare lemnisci
Nucleus olivaris accessorius dorsalis
Raphe
Fibrae arcuatae externae
Fibrae arcuatae externae (to the corpus restiforme)
Hilus nuclei olivaris
N. hypoglossus
Nucleus olivaris inferior
Nucleus arcuatus
Pyramis [medullae oblongatae]
Nucleus olivaris accessorius medialis

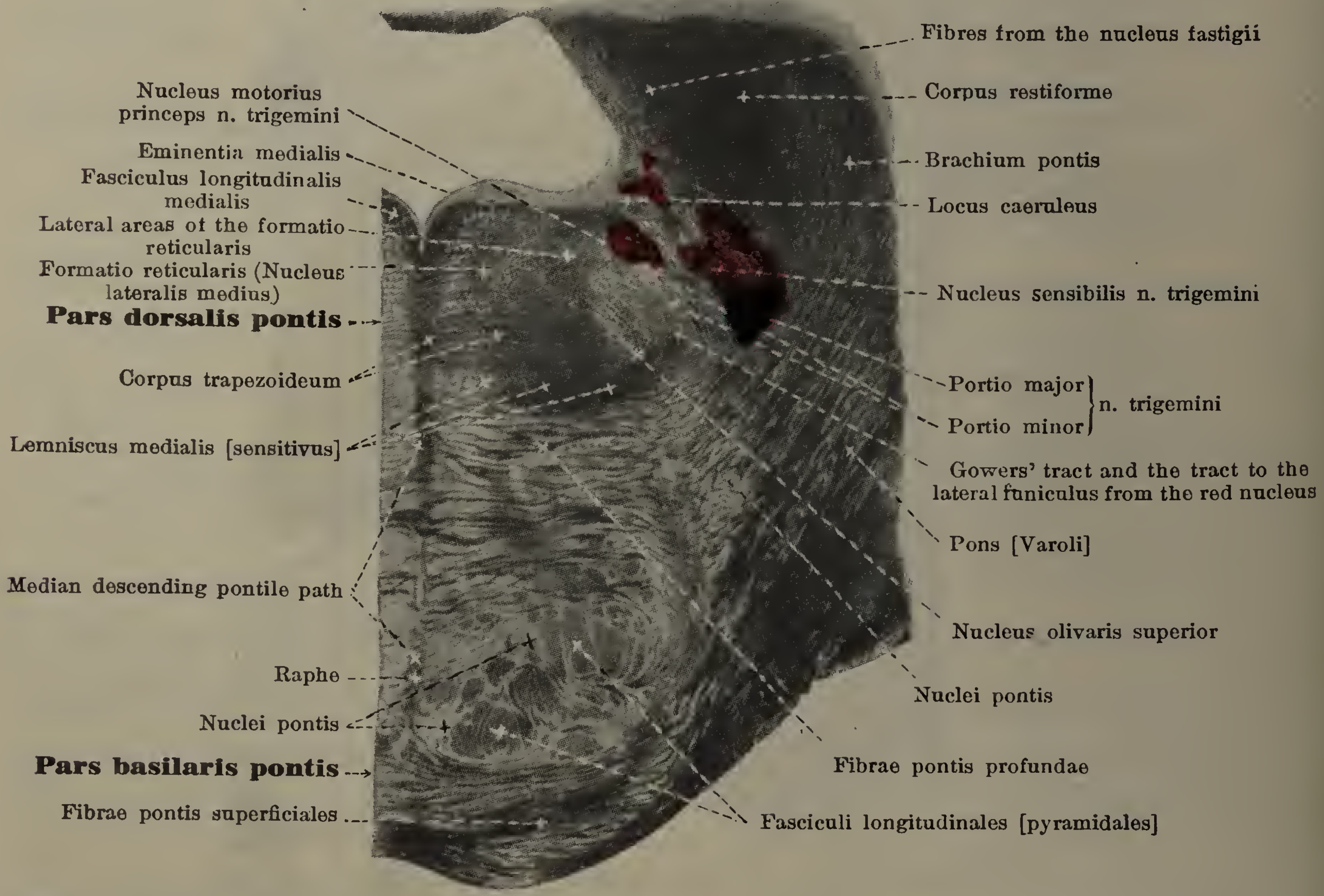
780. Through the middle of the olives. Magnification: 4.5:1.


Stria medullaris
Nucleus tractus solitarii
Radix descendens n. vestibularis
Nucleus n. vestibularis medialis [Schwalbe]
Corpus restiforme
Stria medullaris
Fila radicularia n. vagi
Lateral areas of the formatio reticularis
Dorsal path to trapezoid body from ventral nucleus of cochlear nerve
Substantia reticularis grisea (Nucleus lateralis inferior)
Tuberculum acusticum
Sulcus medianus fossae rhomboideae
Tractus solitarius
Fila radicularia n. glossopharyngei
Fasciculus longitudinalis medialis
Nucleus ambiguus
Nucleus n. cochlearis ventralis
Striae medullares
Fibrae cerebelloolivares
Pons [Varoli]
Raphe
N. cochlearis
Stratum interolivare lemnisci
Nucleus tractus spinalis n. trigemini
Fibrae cerebelloolivares
Gowers' tract and the tract to the lateral funiculus from Deiters' nucleus and from the red nucleus
Nucleus olivaris accessorius dorsalis
Hilus nuclei olivaris
Nucleus olivaris inferior
Nucleus olivaris accessorius medialis
Nucleus arcuatus
Pyramis [medullae oblongatae]

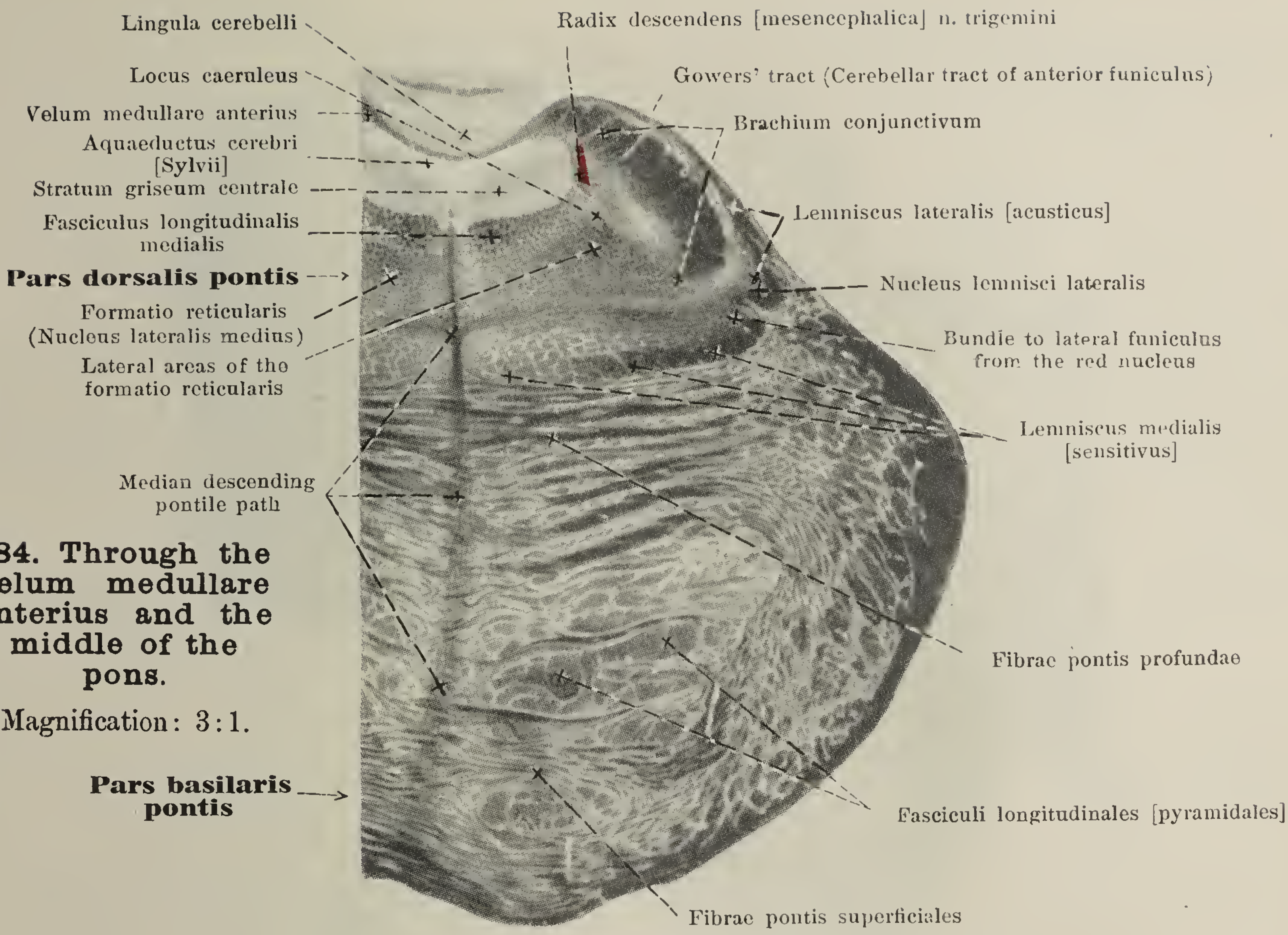
781. Through the level of entrance of the n. acusticus. Magnification: 4.5:1.


Nucleus n. vestibularis superior [Flechsig, Bechterew]
Fibres from the nucleus fastigii
Nucleus n. vestibularis medialis [Schwalbe]
Nucleus dentatus
Fovea superior
Lateral areas of the formatio reticularis
Nucleus n. abducentis
Colliculus facialis
Corpus restiforme
Genu [internum] radicis n. facialis
Fasciculus longitudinalis medialis
Nervus vestibularis
Formatio reticularis
Nucleus tractus spinalis n. trigemini
Nucleus n. facialis
Bundle to lateral funiculus from Deiters' nucleus
Tractus spinalis n. trigemini
Radix n. abducentis
Lemniscus medialis [sensitivus]
Pons [Varoli]
Median descending pontile path
Radix n. facialis (pars secunda)
Gowers' tract and the tract to the lateral funiculus from the red nucleus
Nucleus olivaris superior
Nuclei pontis
Corpus trapezoideum
Fibrae pontis superficiales
Fibrae pontis profundae
Fasciculi longitudinales [pyramidales]

782. Level of the roots of the n. facialis and n. abducens. Magnification: 3:1.

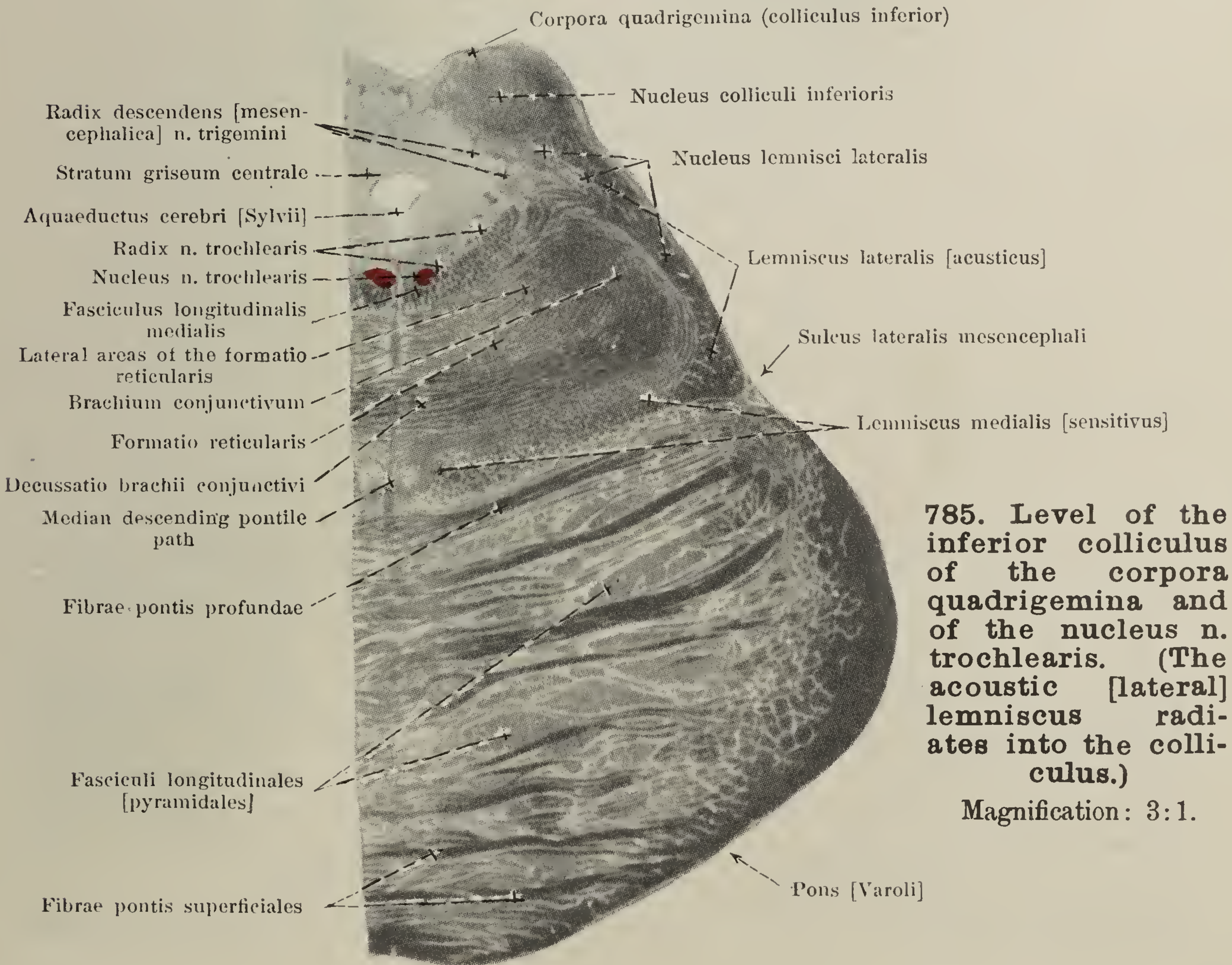

Fibres from the nucleus fastigii
Nucleus motorius princeps n. trigemini
Corpus restiforme
Eminentia medialis
Brachium pontis
Fasciculus longitudinalis medialis
Locus caeruleus
Lateral areas of the formatio reticularis
Formatio reticularis (Nucleus lateralis medius)
Nucleus sensibilis n. trigemini
Pars dorsalis pontis
Corpus trapezoideum
Portio major
Portio minor
n. trigemini
Lemniscus medialis [sensitivus]
Gowers' tract and the tract to the lateral funiculus from the red nucleus
Pons [Varoli]
Median descending pontile path
Nucleus olivaris superior
Raphe
Nuclei pontis
Nuclei pontis
Pars basilaris pontis
Fibrae pontis profundae
Fibrae pontis superficiales
Fasciculi longitudinales [pyramidales]

783. Level of the roots of the n. trigeminus. Magnification: 3:1.


Lingula cerebelli
Locus caeruleus
Velum medullare anterius
Aquaeductus cerebri [Sylvii]
Stratum griseum centrale
Fasciculus longitudinalis medialis
Pars dorsalis pontis
Formatio reticularis (Nucleus lateralis medius)
Lateral areas of the formatio reticularis
Median descending pontile path
Pars basilaris pontis
Radix descendens [mesencephalica] n. trigemini
Gowers' tract (Cerebellar tract of anterior funiculus)
Brachium conjunctivum
Lemniscus lateralis [acusticus]
Nucleus lemnisci lateralis
Bundle to lateral funiculus from the red nucleus
Lemniscus medialis [sensitivus]
Fibrae pontis profundae
Fasciculi longitudinales [pyramidales]
Fibrae pontis superficiales

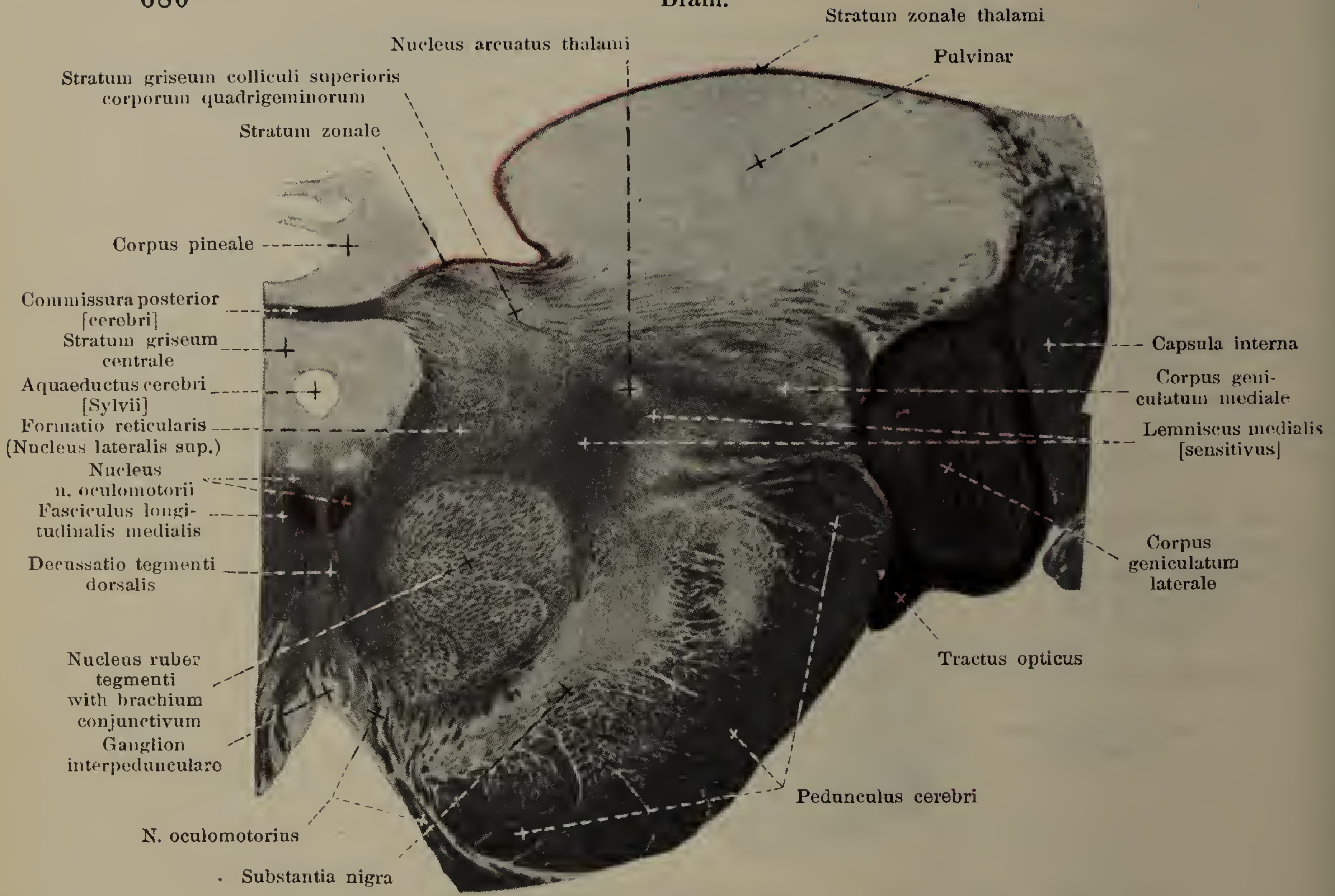
784. Through the velum medullare anterius and the middle of the pons.

Magnification: 3:1.

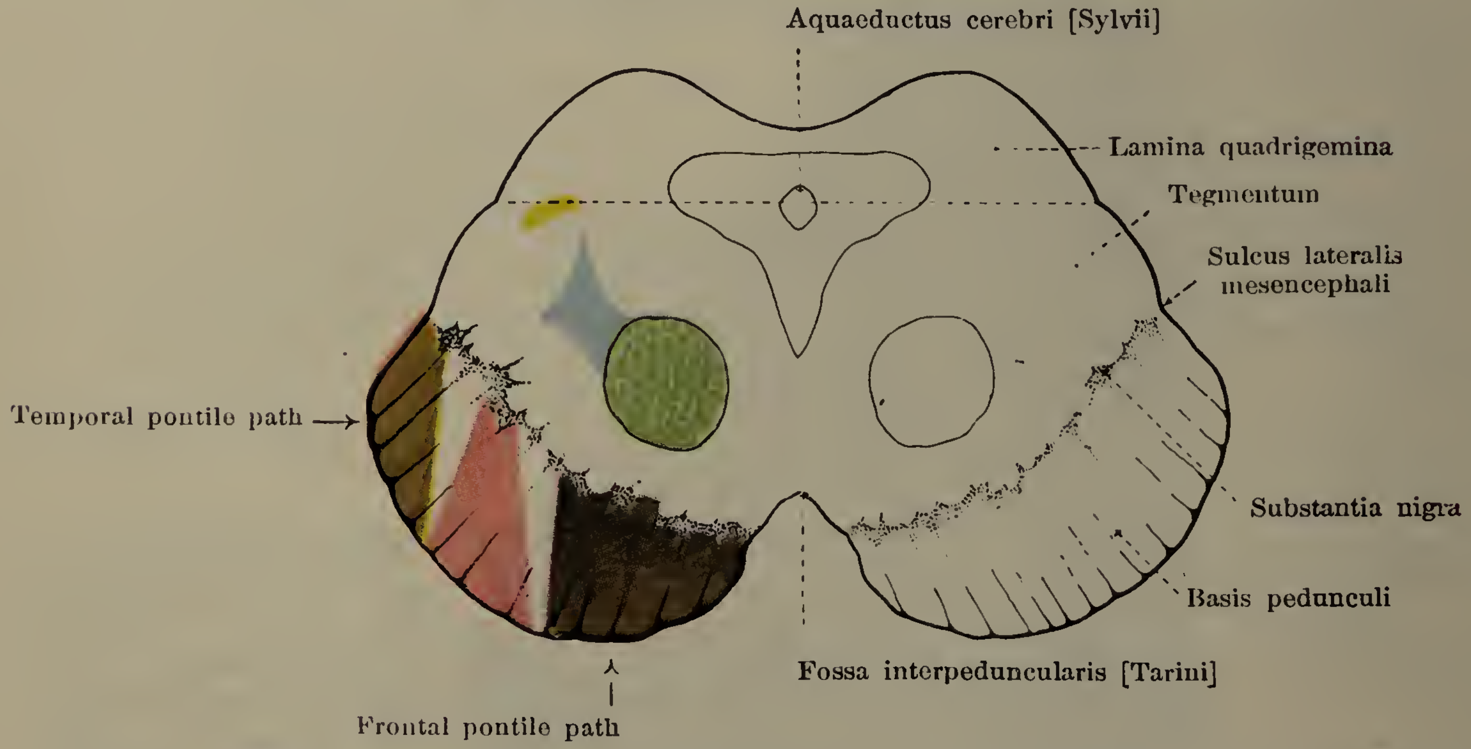

Corpora quadrigemina (colliculus inferior)
Nucleus colliculi inferioris
Radix descendens [mesencephalica] n. trigemini
Nucleus lemnisci lateralis
Stratum griseum centrale
Aquaeductus cerebri [Sylvii]
Radix n. trochlearis
Lemniscus lateralis [acusticus]
Nucleus n. trochlearis
Fasciculus longitudinalis medialis
Sulcus lateralis mesencephali
Lateral areas of the formatio reticularis
Brachium conjunctivum
Lemniscus medialis [sensitivus]
Formatio reticularis
Decussatio brachii conjunctivi
Median descending pontile path
Fibrae pontis profundae
Fasciculi longitudinales [pyramidales]
Pons [Varoli]
Fibrae pontis superficiales

785. Level of the inferior colliculus of the corpora quadrigemina and of the nucleus n. trochlearis. (The acoustic [lateral] lemniscus radiates into the colliculus.)

Magnification: 3:1.

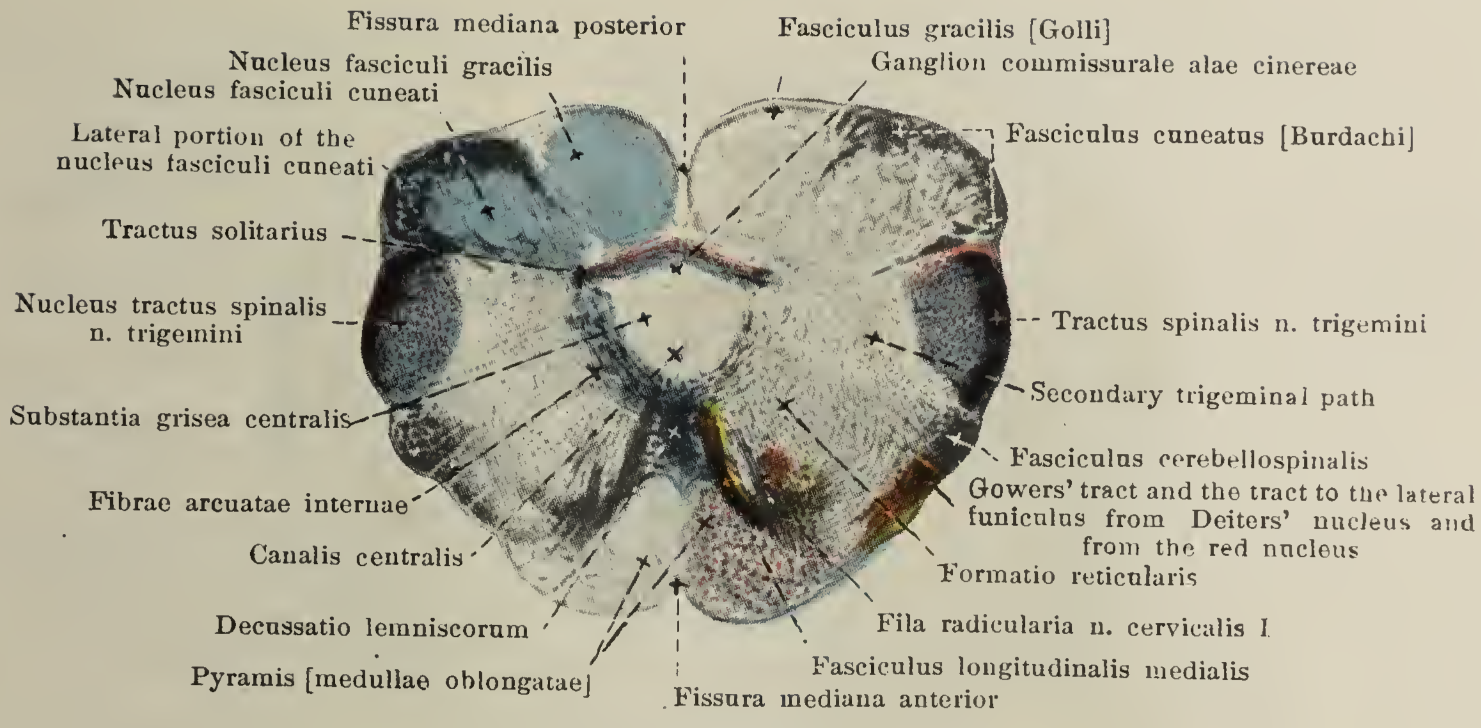

Stratum zonale thalami
Nucleus arcuatus thalami
Pulvinar
Stratum griseum colliculi superioris corporum quadrigeminorum
Stratum zonale
Corpus pineale
Commissura posterior [cerebri]
Stratum griseum centrale
Aquaeductus cerebri [Sylvii]
Formatio reticularis (Nucleus lateralis sup.)
Nucleus n. oculomotorii
Fasciculus longitudinalis medialis
Decussatio tegmenti dorsalis
Nucleus ruber tegmenti with brachium conjunctivum
Ganglion interpedunculare
N. oculomotorius
Substantia nigra
Capsula interna
Corpus geniculatum mediale
Lemniscus medialis [sensitivus]
Corpus geniculatum laterale
Tractus opticus
Pedunculus cerebri

786. Level of root of n. oculomotorius. Magnification: 3:1.

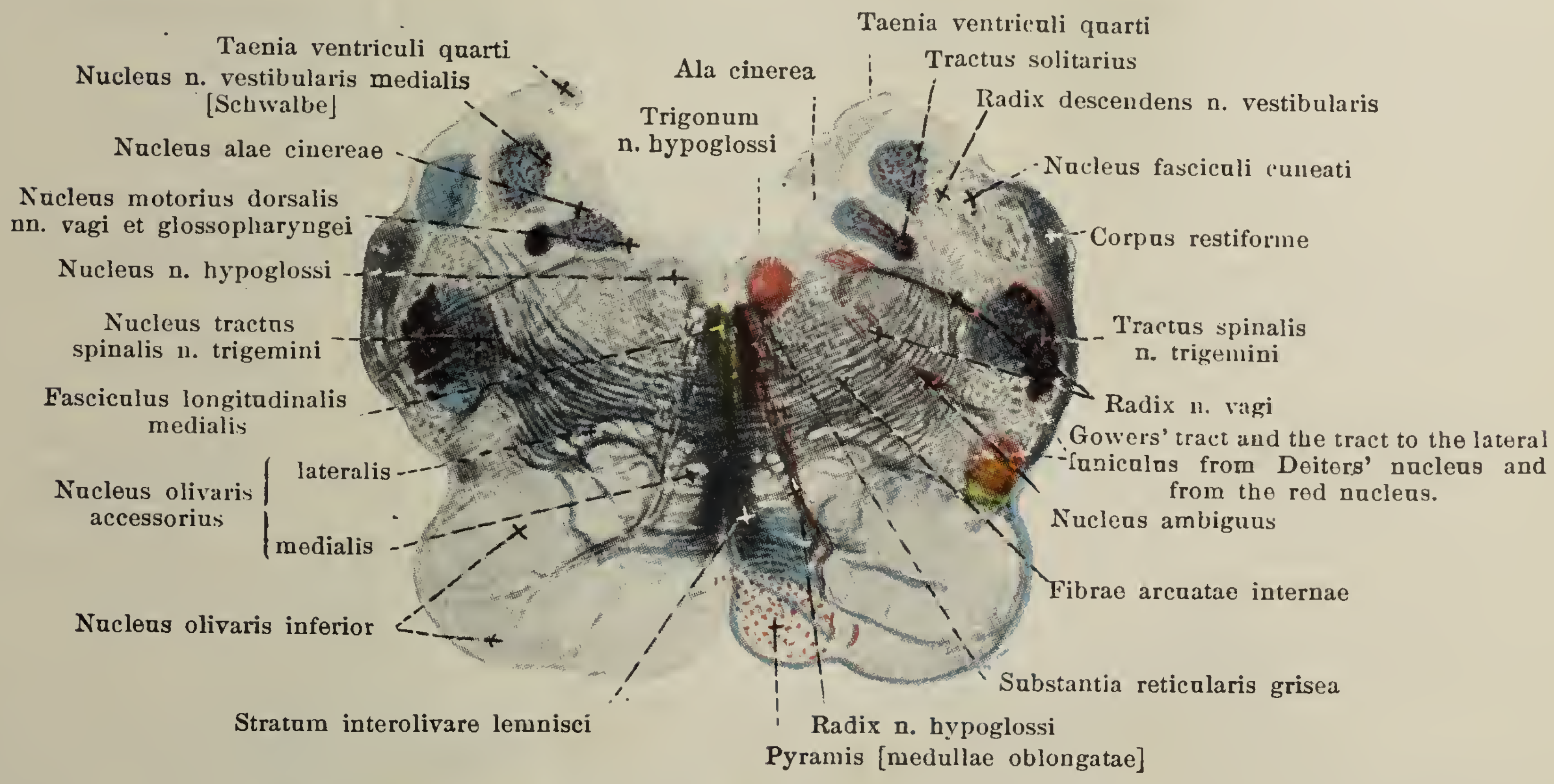


787. Transverse section through the corpora quadrigemina and cerebral peduncles, somewhat schematic. Pyramidal tract red; medial lemniscus to the [ventro]lateral nucleus of the thalamus blue; brachium conjunctivum green; auditory path yellow; temporal pontile path (Türck's bundle) light brown; frontal pontile path (Arnold's bundle) dark brown. (Held.)

(The sections represented by Figs. 778—796 are regularly so arranged that their dorsal margins are upward.)


Fissura mediana posterior
Nucleus fasciculi gracilis
Nucleus fasciculi cuneati
Lateral portion of the nucleus fasciculi cuneati
Tractus solitarius
Nucleus tractus spinalis n. trigemini
Substantia grisea centralis
Fibrae arcuatae internae
Canalis centralis
Decussatio lemniscorum
Pyramis [medullae oblongatae]
Fasciculus gracilis [Golli]
Ganglion commissurale alae cinereae
Fasciculus cuneatus [Burdachi]
Tractus spinalis n. trigemini
Secondary trigeminal path
Fasciculus cerebellospinalis
Gowers' tract and the tract to the lateral funiculus from Deiters' nucleus and from the red nucleus
Formatio reticularis
Fila radicularia n. cervicalis I
Fasciculus longitudinalis medialis
Fissura mediana anterior

788. Level of the sensory decussation (Decussatio lemniscorum).


Taenia ventriculi quarti
Nucleus n. vestibularis medialis [Schwalbe]
Nucleus alae cinereae
Nucleus motorius dorsalis nn. vagi et glossopharyngei
Nucleus n. hypoglossi
Nucleus tractus spinalis n. trigemini
Fasciculus longitudinalis medialis
Nucleus olivaris accessorius
lateralis
medialis
Nucleus olivaris inferior
Stratum interolivare lemnisci
Ala cinerea
Trigonum n. hypoglossi
Taenia ventriculi quarti
Tractus solitarius
Radix descendens n. vestibularis
Nucleus fasciculi cuneati
Corpus restiforme
Tractus spinalis n. trigemini
Radix n. vagi
Gowers' tract and the tract to the lateral funiculus from Deiters' nucleus and from the red nucleus.
Nucleus ambiguus
Fibrae arcuatae internae
Substantia reticularis grisea
Radix n. hypoglossi
Pyramis [medullae oblongatae]

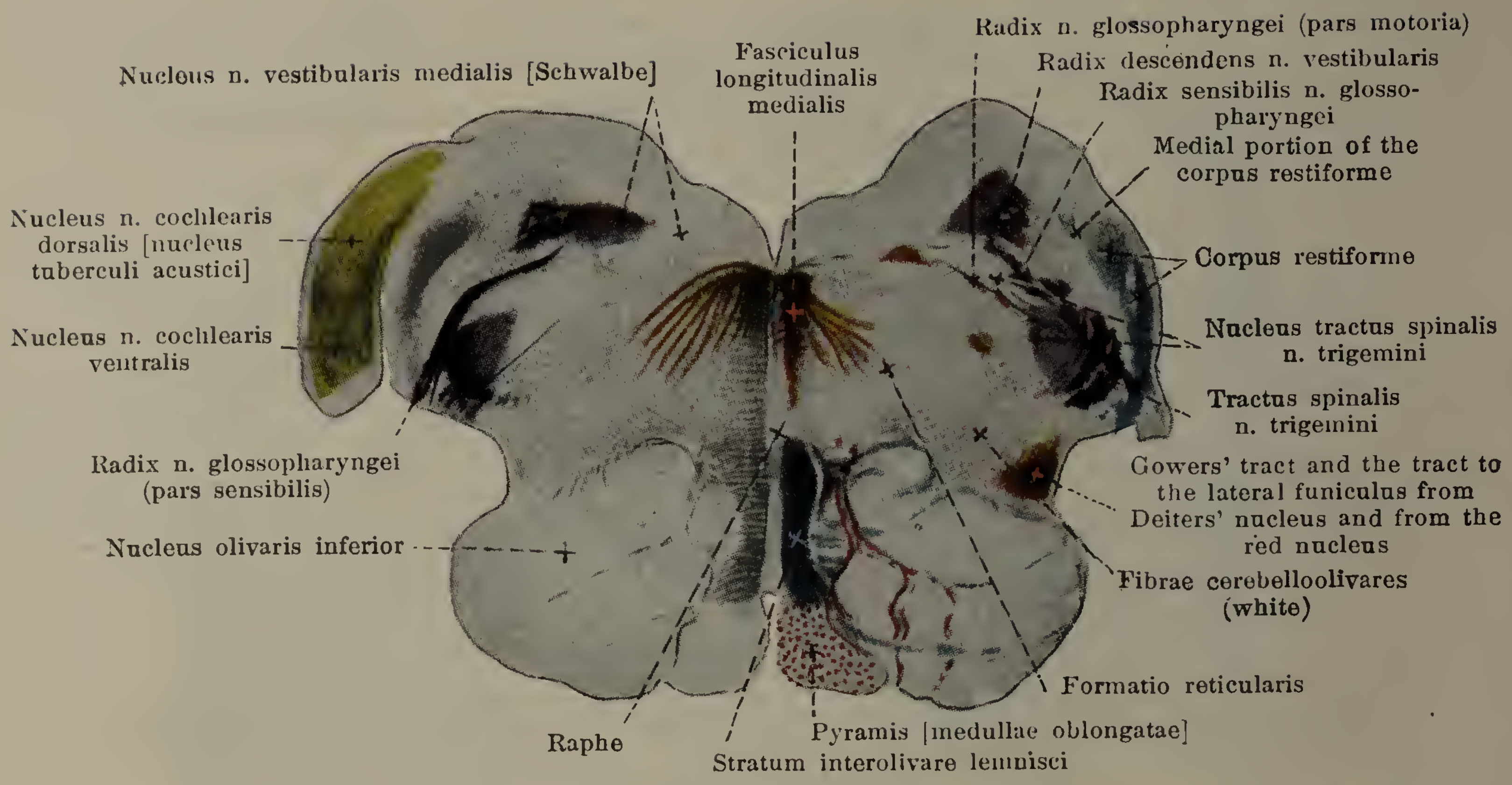
789. Level of radix n. hypoglossi and radix n. vagi.

788—795. Transverse sections through the brainstem of an 8—9 month fetus; the nerve fibres are not yet completely medullated.

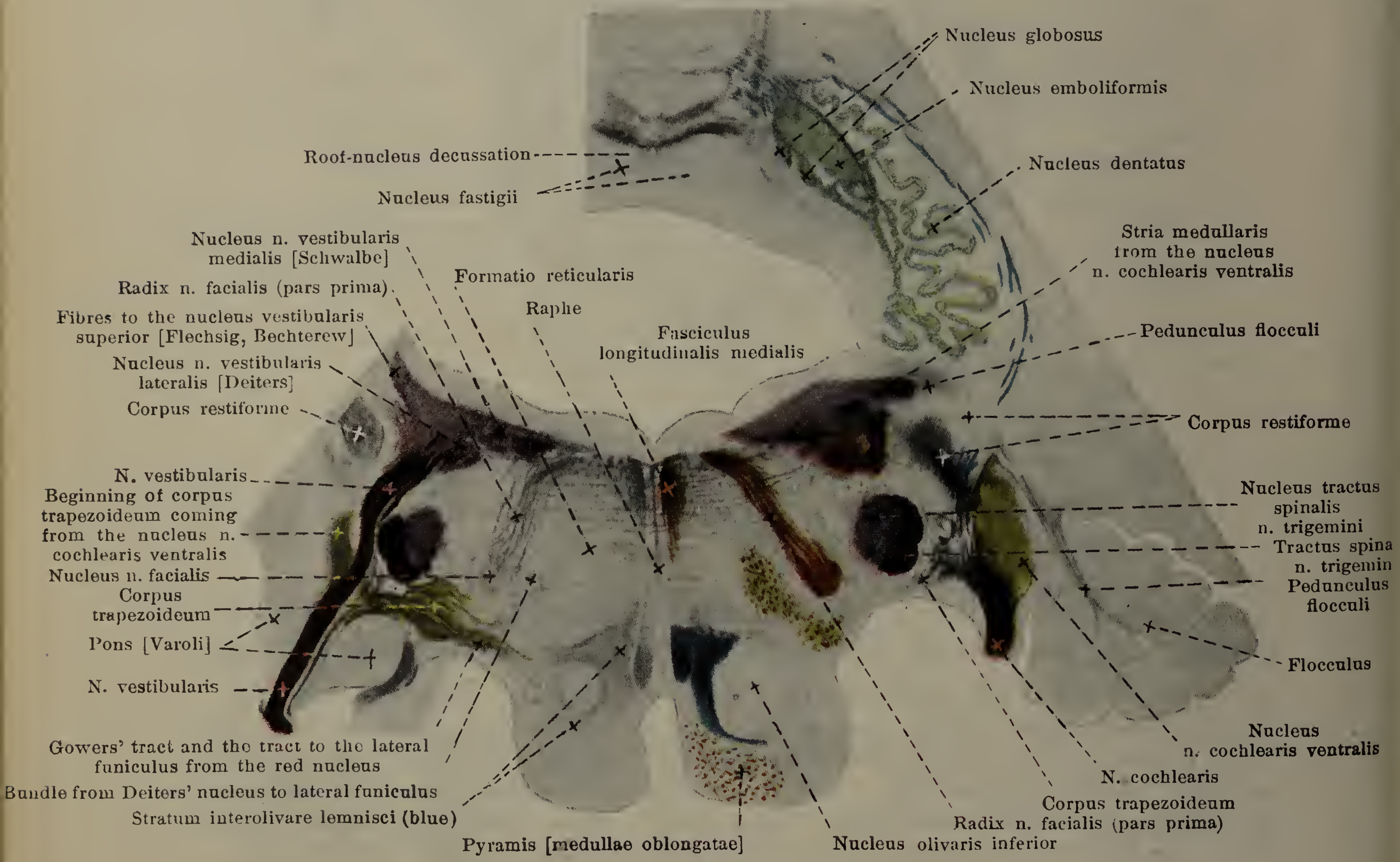
Magnification: 6:1. White matter black; gray matter light. Motor roots and nuclei, as well as the pyramidal tract red; roots and primary terminal nuclei of the sensory cerebral nerves (except the yellow-colored n. cochlearis and its indirect continuations) violet; secondary (ascending) paths from the nuclei of the posterior funiculi blue; brachium conjunctivum green. (Held.)

Concerning the level and direction of the sections see Fig. 777.

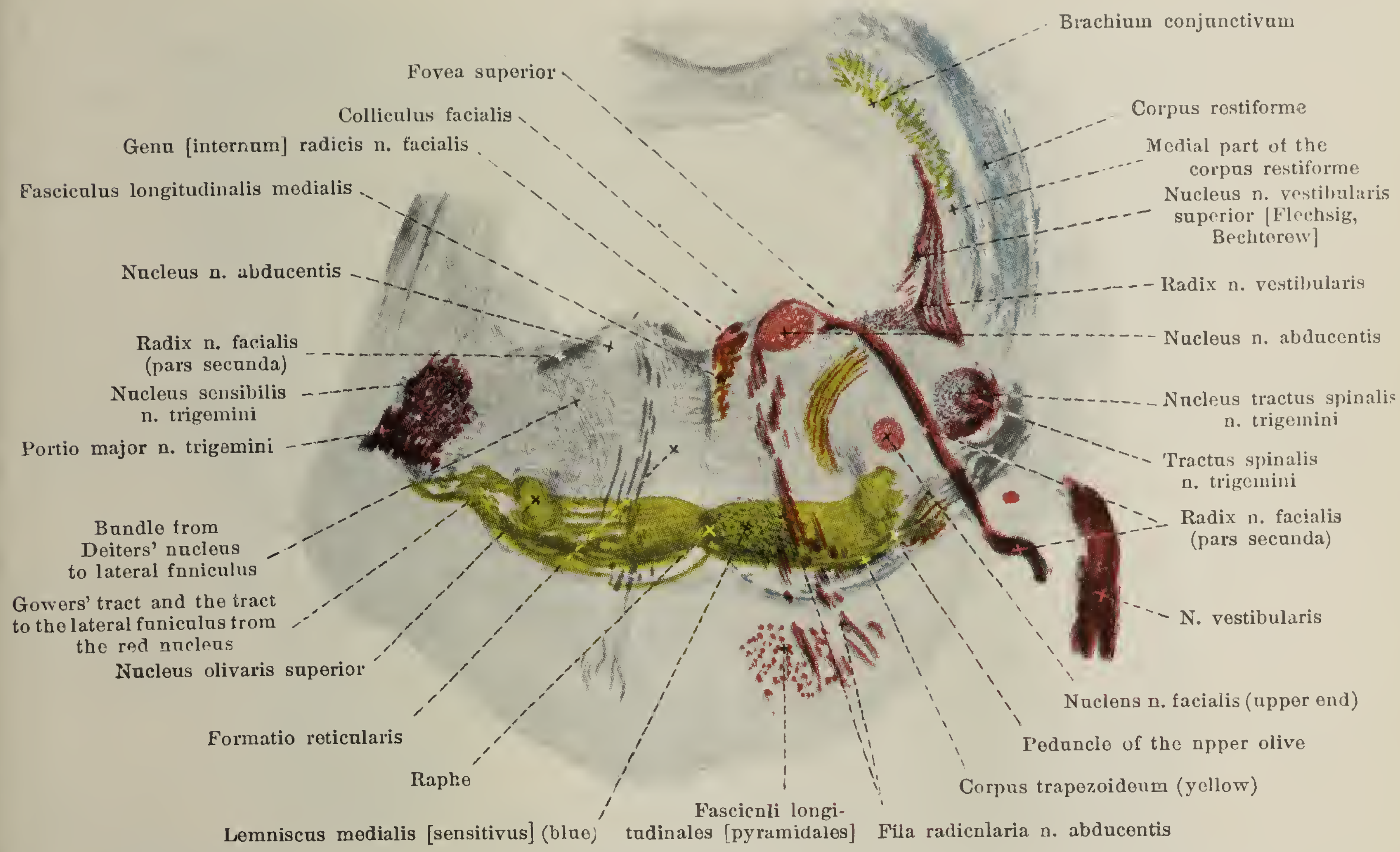
(The sections represented by Figs. 778—796 are so arranged that their dorsal margins are upward.)


Nucleus n. vestibularis medialis [Schwalbe]
Fasciculus longitudinalis medialis
Radix n. glossopharyngei (pars motoria)
Radix descendens n. vestibularis
Radix sensibilis n. glossopharyngei
Medial portion of the corpus restiforme
Nucleus n. cochlearis dorsalis [nucleus tuberculi acustici]
Corpus restiforme
Nucleus n. cochlearis ventralis
Nucleus tractus spinalis n. trigemini
Tractus spinalis n. trigemini
Radix n. glossopharyngei (pars sensibilis)
Gowers' tract and the tract to the lateral funiculus from Deiters' nucleus and from the red nucleus
Nucleus olivaris inferior
Fibrae cerebelloolivares (white)
Formatio reticularis
Raphe
Pyramis [medullae oblongatae]
Stratum interolivare lemnisci

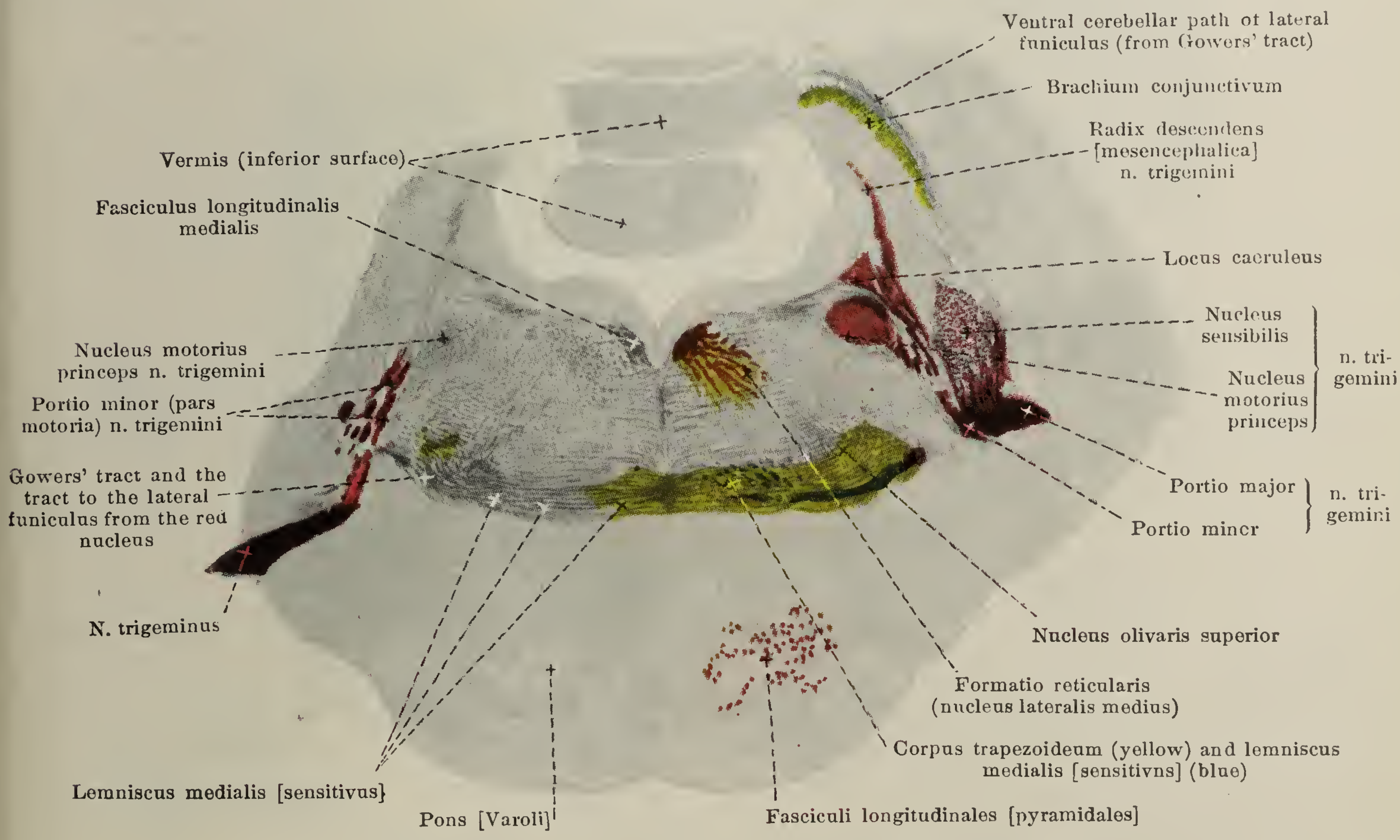
790. Level of the tuberculum acusticum (on the left side) and of the radix n. glossopharyngei.


Nucleus globosus
Nucleus emboliformis
Roof-nucleus decussation
Nucleus fastigii
Nucleus dentatus
Nucleus n. vestibularis medialis [Schwalbe]
Stria medullaris from the nucleus n. cochlearis ventralis
Radix n. facialis (pars prima)
Formatio reticularis
Raphe
Fibres to the nucleus vestibularis superior [Flechsig, Bechterew]
Fasciculus longitudinalis medialis
Pedunculus flocculi
Nucleus n. vestibularis lateralis [Deiters]
Corpus restiforme
Corpus restiforme
N. vestibularis
Beginning of corpus trapezoideum coming from the nucleus n. cochlearis ventralis
Nucleus tractus spinalis n. trigemini
Tractus spina n. trigemin
Nucleus n. facialis
Corpus trapezoideum
Pedunculus flocculi
Pons [Varoli]
Flocculus
N. vestibularis
Nucleus n. cochlearis ventralis
Gowers' tract and the tract to the lateral funiculus from the red nucleus
N. cochlearis
Bundle from Deiters' nucleus to lateral funiculus
Corpus trapezoideum
Stratum interolivare lemnisci (blue)
Radix n. facialis (pars prima)
Pyramis [medullae oblongatae]
Nucleus olivaris inferior

791. Level of entrance of the n. acusticus (left side: n. vestibularis, right side: n. cochlearis) and, on the left, of the exit of the n. facialis.

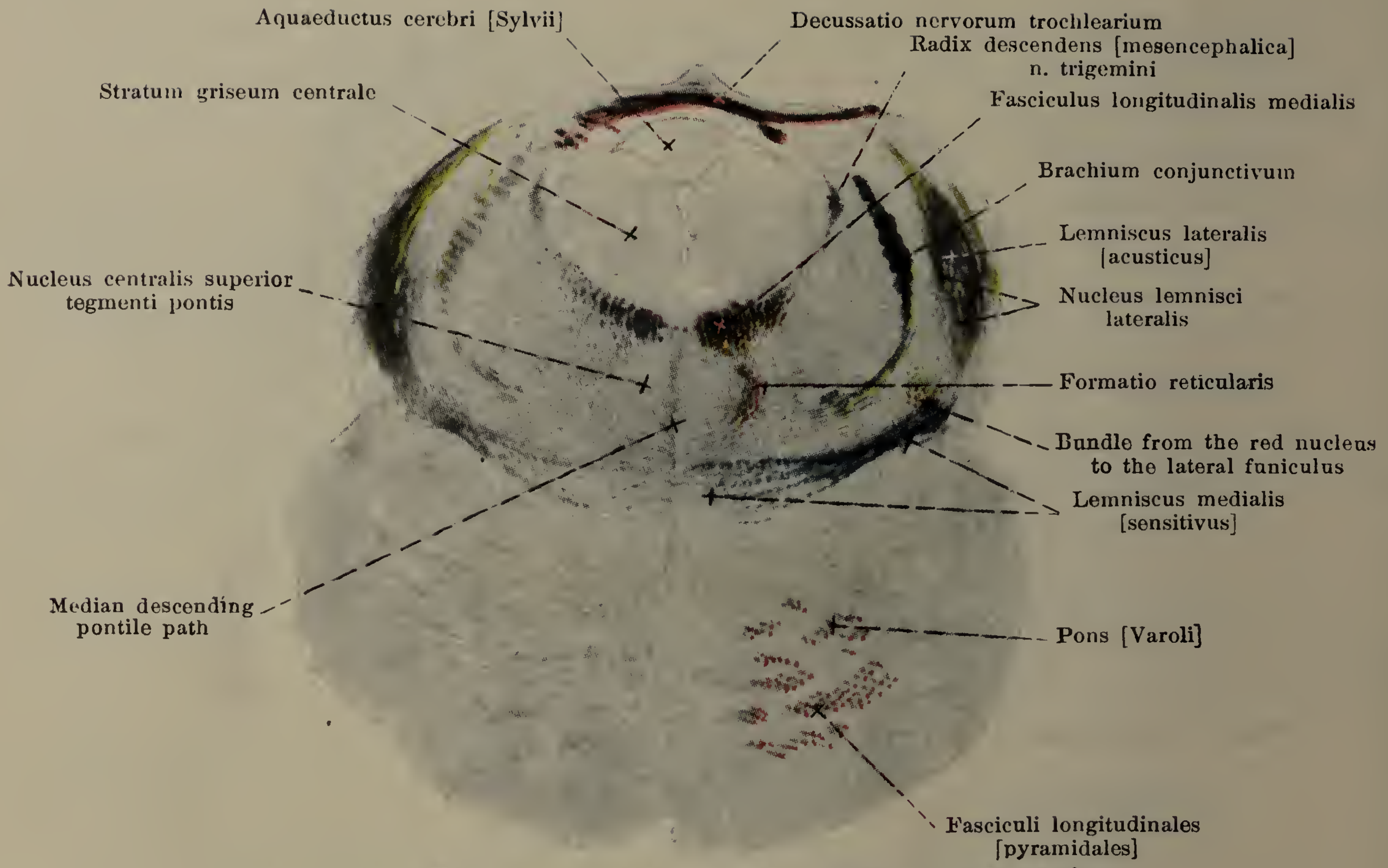

Brachium conjunctivum
Fovea superior
Corpus restiforme
Colliculus facialis
Genu [internum] radicis n. facialis
Medial part of the corpus restiforme
Fasciculus longitudinalis medialis
Nucleus n. vestibularis superior [Flechsig, Bechterew]
Nucleus n. abducentis
Radix n. vestibularis
Nucleus n. abducentis
Radix n. facialis (pars secunda)
Nucleus sensibilis n. trigemini
Nucleus tractus spinalis n. trigemini
Portio major n. trigemini
Tractus spinalis n. trigemini
Bundle from Deiters' nucleus to lateral funiculus
Radix n. facialis (pars secunda)
Gowers' tract and the tract to the lateral funiculus from the red nucleus
N. vestibularis
Nucleus olivaris superior
Nucleus n. facialis (upper end)
Formatio reticularis
Peduncle of the upper olive
Raphe
Corpus trapezoideum (yellow)
Fasciculi longitudinales [pyramidales]
Lemniscus medialis [sensitivus] (blue)
Fila radicularia n. abducentis

792. Level of exit of the n. facialis and of the nucleus n. abducentis.

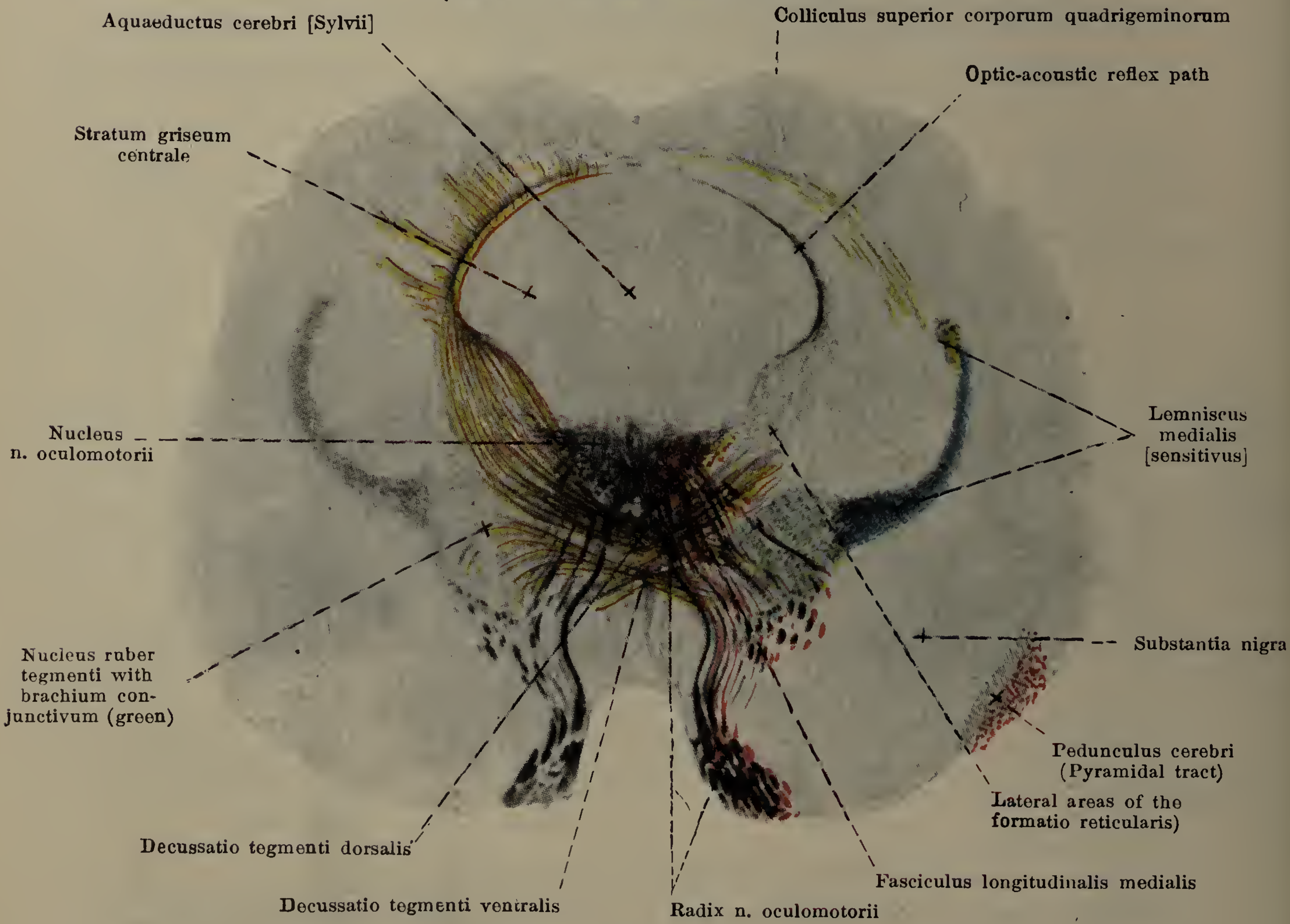

Ventral cerebellar path of lateral funiculus (from Gowers' tract)
Brachium conjunctivum
Vermis (inferior surface)
Radix descendens [mesencephalica] n. trigemini
Fasciculus longitudinalis medialis
Locus caeruleus
Nucleus sensibilis
Nucleus motorius princeps
n. trigemini
Nucleus motorius princeps n. trigemini
Portio minor (pars motoria) n. trigemini
Gowers' tract and the tract to the lateral funiculus from the red nucleus
Portio major
Portio minor
n. trigemini
N. trigeminus
Nucleus olivaris superior
Formatio reticularis (nucleus lateralis medius)
Corpus trapezoideum (yellow) and lemniscus medialis [sensitivus] (blue)
Lemniscus medialis [sensitivus]
Pons [Varoli]
Fasciculi longitudinales [pyramidales]

793. Level of roots of the n. trigeminus.

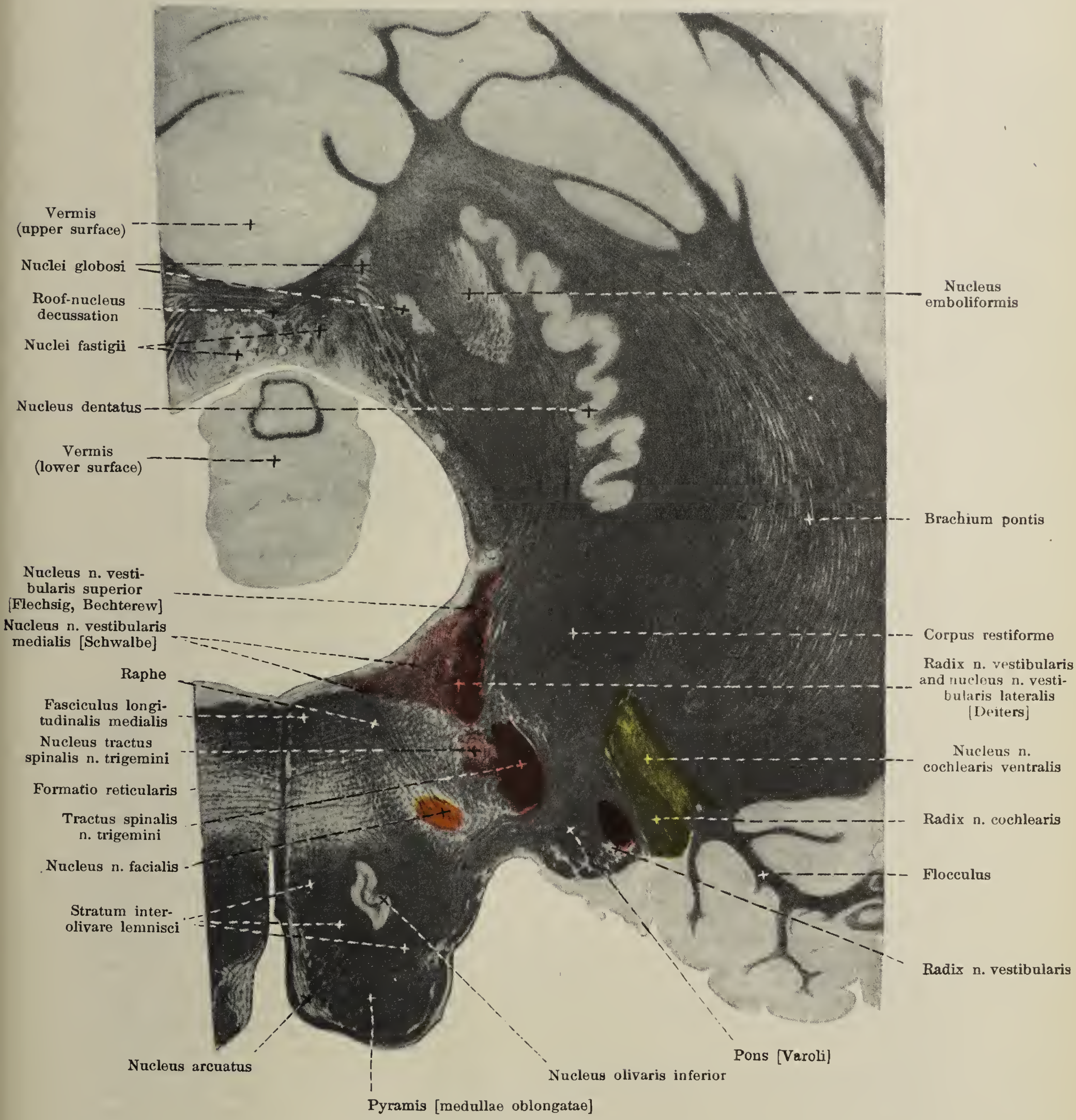
792 and 793. Region of the corpus trapezoideum.


Aquaeductus cerebri [Sylvii]
Decussatio nervorum trochlearium
Radix descendens [mesencephalica] n. trigemini
Stratum griseum centrale
Fasciculus longitudinalis medialis
Brachium conjunctivum
Lemniscus lateralis [acusticus]
Nucleus centralis superior tegmenti pontis
Nucleus lemnisci lateralis
Formatio reticularis
Bundle from the red nucleus to the lateral funiculus
Lemniscus medialis [sensitivus]
Median descending pontile path
Pons [Varoli]
Fasciculi longitudinales [pyramidales]

794. Level of the decussatio nervorum trochlearium
(radix n. trochlearis see Fig. 785).


Aquaeductus cerebri [Sylvii]
Colliculus superior corporum quadrigeminorum
Optic-acoustic reflex path
Stratum griseum centrale
Nucleus n. oculomotorii
Lemniscus medialis [sensitivus]
Substantia nigra
Nucleus ruber tegmenti with brachium conjunctivum (green)
Pedunculus cerebri (Pyramidal tract)
Lateral areas of the formatio reticularis)
Decussatio tegmenti dorsalis
Fasciculus longitudinalis medialis
Decussatio tegmenti ventralis
Radix n. oculomotorii

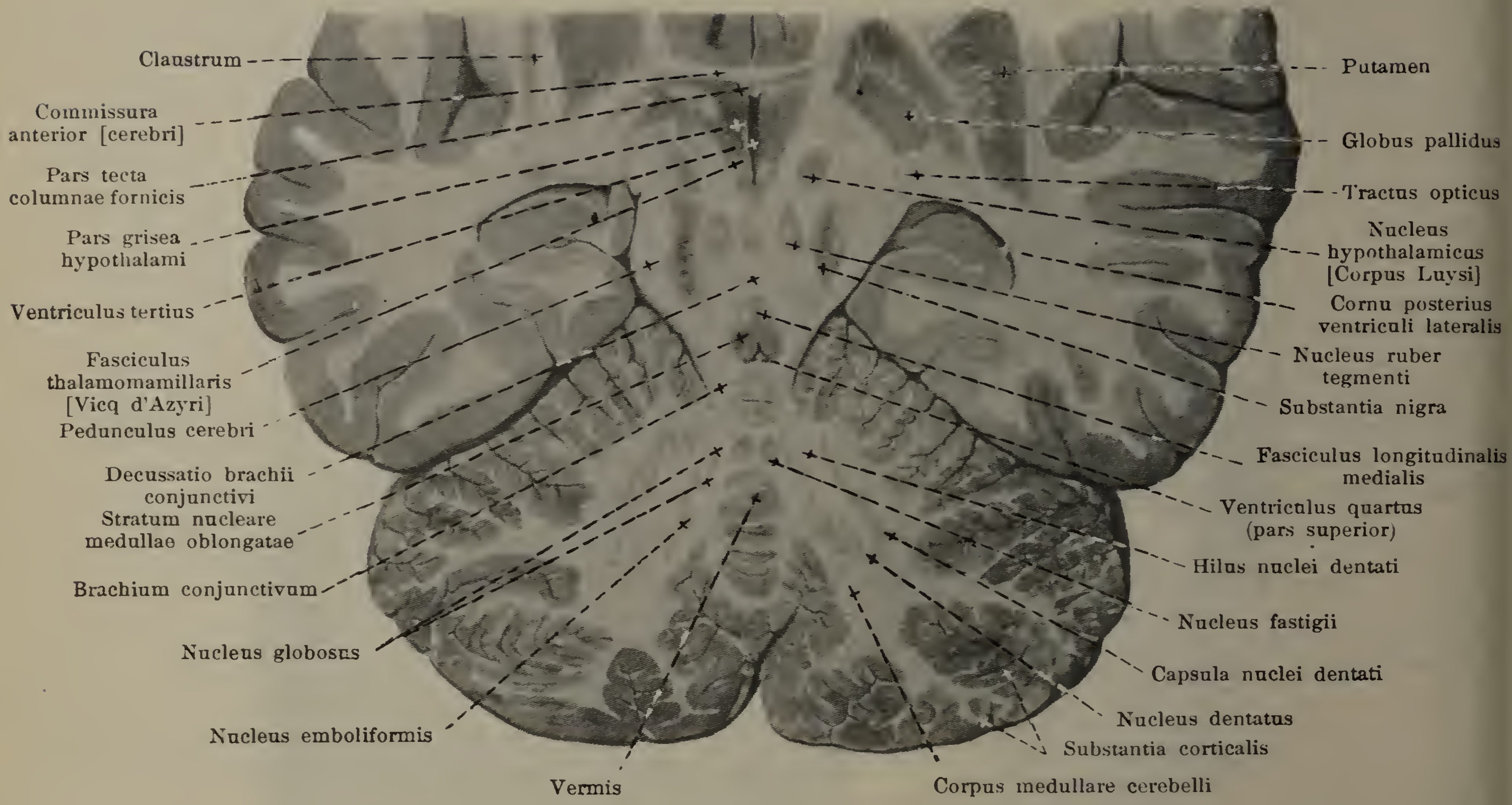
795. Level of exit of the n. oculomotorius.


Vermis (upper surface)
Nuclei globosi
Roof-nucleus decussation
Nuclei fastigii
Nucleus dentatus
Vermis (lower surface)
Nucleus n. vestibularis superior [Flechsig, Bechterew]
Nucleus n. vestibularis medialis [Schwalbe]
Raphe
Fasciculus longitudinalis medialis
Nucleus tractus spinalis n. trigemini
Formatio reticularis
Tractus spinalis n. trigemini
Nucleus n. facialis
Stratum interolivare lemnisci
Nucleus arcuatus
Pyramis [medullae oblongatae]
Nucleus olivaris inferior
Pons [Varoli]
Nucleus emboliformis
Brachium pontis
Corpus restiforme
Radix n. vestibularis and nucleus n. vestibularis lateralis [Deiters]
Nucleus n. cochlearis ventralis
Radix n. cochlearis
Flocculus
Radix n. vestibularis

796. Section through the middle of the cerebellum and through the medulla oblongata.

Approximately in the direction of the radiation of the corpora restiformia (after a preparation by P. Flechsig). Magnification: 4:1. (Held.) White substance black; gray substance light.

Motor nuclei red, sensory blue, acoustic yellow.


Claustrum
Commissura anterior [cerebri]
Pars tecta columnae fornicis
Pars grisea hypothalami
Ventriculus tertius
Fasciculus thalamomamillaris [Vicq d'Azyri]
Pedunculus cerebri
Decussatio brachii conjunctivi
Stratum nucleare medullae oblongatae
Brachium conjunctivum
Nucleus globosus
Nucleus emboliformis
Vermis
Corpus medullare cerebelli
Substantia corticalis
Nucleus dentatus
Capsula nuclei dentati
Nucleus fastigii
Hilus nuclei dentati
Ventriculus quartus (pars superior)
Fasciculus longitudinalis medialis
Substantia nigra
Nucleus ruber tegmenti
Cornu posterius ventriculi lateralis
Nucleus hypothalamicus [Corpus Luysi]
Tractus opticus
Globus pallidus
Putamen

797. Section through the brain in the direction of the brachia conjunctiva.

Distribution of the principal masses of gray and white matter in the brain. In the region of transition from the spinal cord to the medulla oblongata the masses of white and gray matter undergo greater or less alterations in character and position; and farthermore new masses of grey matter appear and corresponding to them new tracts of white fibres. A specially marked shifting of individual parts is brought about by the separation of the parts of the spinal cord situated dorsally from the central canal, in such a manner that the dorsal masses of the cord are moved laterally and the central canal opens up as a transversely striated slit. Consequently the form and delineation of the cross-sections is different at different levels.

Even in the cervical region peculiarities are to be noted in that the fibres of the n. accessorius from the anterior horn (see p. 700), in the region of the upper 5—7 cervical segments, run outward through the lateral tract.

At the level of the root fibres of the 1st cervical nerve (see Fig. 778) the fibre bundles of the *fasciculus cerebrospinalis lateralis [pyramidalis lateralis] (lateral pyramidal tract)* run through the anterior horn obliquely medianward, ventralward and upward, cross the middle line *(decussatio pyramidum)* (see also p. 649) and join the *fasciculus cerebrospinalis anterior (anterior pyramidal tract)* of the opposite side forming together the *pyramis [medullae oblongatae]* (see Figs. 778—781, 788—791 and 796), nearly triangular in cross section, which projects from the ventral surface of the medulla oblongata as a prominence directly next to the fissura mediana anterior (see p. 648), and which extends as a close and distinct mass to the lower border of the pons; the bundles forming the pyramis, *fasciculi pyramidales,* are continued cerebralward directly in the fasciculi longitudinales [pyramidales] of the pons (see p. 688), and are separated by the transverse fibres of the latter into bundles of different thicknesses.

In the region of the pyramidal decussation (see Figs. 778, 779 and 788) there appears in the fasciculus gracilis a long wedge-shaped mass of gray matter, the *nucleus fasciculi gracilis,* which produces the clava (see p. 649) on the surface, and a little further up in the fasciculus cuneatus, there appears the *nucleus fasciculi cuneati,* which corresponds superficially to the tuberculum cuneatum (see p. 649); both are connected with the central gray matter. Corresponding to the divergence of the posterior bundles (see p. 649), their so called *posterior nuclei* are also shifted lateralward (see Fig. 789). They extend upward getting smaller as they go, until about the lower end of the area acustica (see p. 649). The posterior horn corresponding to the decreasing of the lateral pyramidal tract is gradually displaced lateralward and ventralward (see Figs. 778, 779, 788 and 789), and soon disappears altogether; only its substantia gelatinosa [Rolandi] remains, becomes thicker and is continued as a thick, gray mass, the *nucleus tractus spinalis n. trigemini,* which reaches almost to the surface laterally, and is there in contact with the *tractus spinalis n. trigemini* (see also p. 698); it bulges out as the tuberculum cinereum (see p. 649) more noticeably in the child than in the adult.

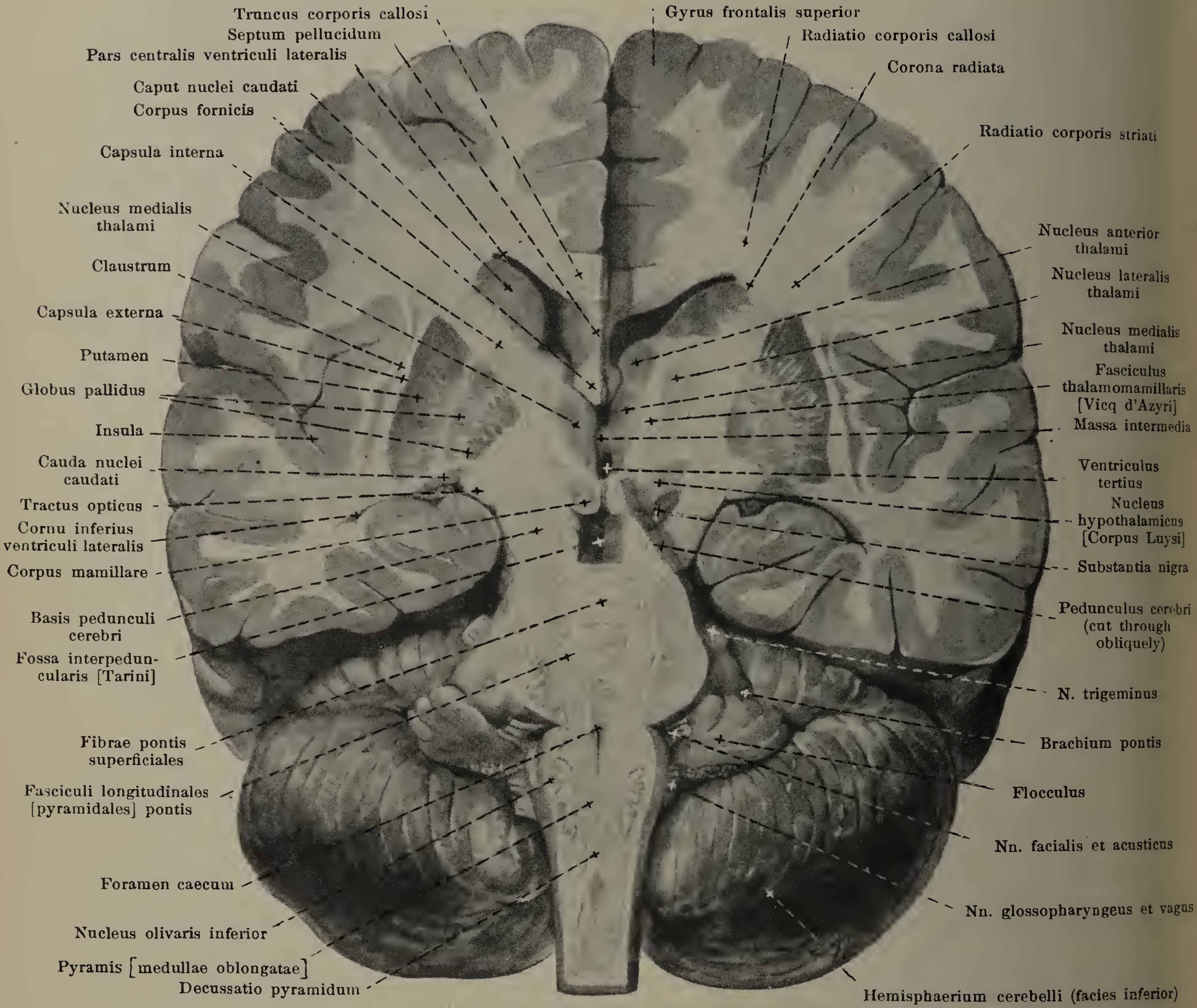
From the cells of the nuclei in the posterior tracts at which all fibres of the posterior tracts terminate, other fibres orginate and run in concentric arches around the central canal medianward, ventralward and cerebralward, *(fibrae arcuatae internae)* (see Figs. 778, 779, 788 and 789). They intersect the fibres of the other side ventrally to the central canal *(decussatio lemniscorum),* and on crossing the median line bend on the other side into a region which lies close to the medially running *raphe*, between the latter and the nucleus olivaris inferior, and directly dorsal to the pyramid, and is known as *stratum interolivare lemnisci,* (see Figs. 780, 781, 789—791 and 796). Below the decussatio lemniscorum adjoins the cerebral end of the decussation of the pyramids and above it extends to near the region of the hypoglossal nuclei. The stratum interolivare lemnisci is continued dorsally directly into the substantia reticularis alba (see below); its fibres run vertically cerebralwards and pass above the olivary nuclei, directly into the lemniscus medialis [sensitivus] (see p. 688).

In the continuation of the laterally displaced upper ends of the posterior tracts and posterior nuclei one can see on cross-section an area of medullated fibres, the *corpus restiforme* (see Figs. 780—783, 789—792 and 796), which extends almost to the surface (see pp. 649 and 700).

With the separation of the spinal cord matter lying dorsal to the central canal and with the widening out of the central canal into the 4th ventricle, the masses of gray matter which were ventral to it *(stratum nucleare medullae oblongatae)* come directly to the surface of the ventricle, and under the floor of the rhomboid fossa and partly further caudalward are situated most of the nuclei of the motor and the primary terminal nuclei of sensory cerebral nerves (see Figs. 780—783, 789—793, 796 and 805) and the ascending nerve tracts from the spinal cord connected with them. As a special structure there appears the *formatio reticularis* (see Figs. 778—785 and 788—796). This consists of partly longitudinal and partly transverse medullated fibres largely interwoven with each other and containing individual ganglion cells or small masses of gray matter. In the lowermost part of the medulla oblongata, in direct connection with the formatio reticularis of the spinal cord (see p. 641), it begins with those remains of the anterior and lateral funiculi which are to be seen above the pyramidal decussation and with the remains of the anterior horns. Below, it lies between the pyramids and olives on the one hand and the nuclei of the posterior funiculi (see abore) on the other; it then approaches close to the floor of the rhomboid fossa and is continued through the dorsal portion of the pons (see p. 688) as far forward as the level of the inferior colliculi of the corpora quadrigemina. The medial region, bounded lateralward by the root fibres of the n. hypoglossus (see Figs. 780 and 789), is relatively poor in ganglion cells and is called the ***substantia reticularis alba*** in contrast with the area situated lateralward from it, the ***substantia reticularis grisea.***

On the ventral side (see Figs. 780—782, 789—791, 796 and 798) the ***nucleus olivaris inferior*** appears in the olive; it is a shell-like, much folded gray mass which is open medianward at the ***hilus nuclei olivaris;*** small detached portions of its gray matter are known as the ***nucleus olivaris accessorius medialis*** and ***dorsalis (medial*** and ***dorsal accessory olive).*** At the same level the ***nuclei arcuati*** (see Figs. 780 and 781), flat masses of gray matter, lie in the ***fibrae arcuatae externae*** (see p. 649 and 700) on the ventral and medial surfaces of the pyramids.

About the level of the lower border of the pons cranialward from the nucleus olivaris inferior lies a poorly defined, small gray mass, the ***nucleus olivaris superior,*** or ***upper olive*** (see Figs. 782, 783, 792 and 793), which is separated from the fibres of the pons, by a strong transverse band, the ***corpus trapezoideum,*** or ***trapezoid body*** (see Figs. 782, 783, 792 and 793). It is thus termed as in lower animals in which the pons does not extend so far down, it is visible as a trapezoid area, free in the ventral surface of the medulla oblongata, laterally to the pyramids between the pons and the olive. The big ganglion cells which lie among the fibres of the trapezoid body, near the middle line, are known as the ***nucleus corporis trapezoidei.*** The trapezoid body originates in the cells of the nucleus n. cochlearis ventralis, runs in bundles through the medial lemniscus and continues (see p. 700) directly into the ***lemniscus lateralis [acusticus]*** (see Figs. 784, 785, 787 and 794), which gradually moves lateralward and dorsalward, comes at the isthmus rhombencephali directly under the surface as the trigonum lemnisci (see p. 655) and ends in the corpora quadrigemina (see p. 700).


Truncus corporis callosi
Septum pellucidum
Pars centralis ventriculi lateralis
Caput nuclei caudati
Corpus fornicis
Capsula interna
Nucleus medialis thalami
Claustrum
Capsula externa
Putamen
Globus pallidus
Insula
Cauda nuclei caudati
Tractus opticus
Cornu inferius ventriculi lateralis
Corpus mamillare
Basis pedunculi cerebri
Fossa interpeduncularis [Tarini]
Fibrae pontis superficiales
Fasciculi longitudinales [pyramidales] pontis
Foramen caecum
Nucleus olivaris inferior
Pyramis [medullae oblongatae]
Decussatio pyramidum
Gyrus frontalis superior
Radiatio corporis callosi
Corona radiata
Radiatio corporis striati
Nucleus anterior thalami
Nucleus lateralis thalami
Nucleus medialis thalami
Fasciculus thalamomamillaris [Vicq d'Azyri]
Massa intermedia
Ventriculus tertius
Nucleus hypothalamicus [Corpus Luysi]
Substantia nigra
Pedunculus cerebri (cut through obliquely)
N. trigeminus
Brachium pontis
Flocculus
Nn. facialis et acusticus
Nn. glossopharyngeus et vagus
Hemisphaerium cerebelli (facies inferior)

798. Section through the brain in the direction of the cerebral peduncles, viewed from in front.

(In the left half of the cerebrum a second cut has been made parallel to the first and a plane situated somewhat further dorsalward represented.)

Lemniscus medialis [sensitivus] (see Figs. 782—787 and 792—795) is the name given to the transversely oval-shaped field of vertically running fibres which lies close to the upper surface of the pons and in which the fibres of the stratum interolivare lemnisci (see p. 687) are directly continued. This band of the medial lemniscus first widens gradually, then moves laterally and dorsalward, close to the lateral lemniscus as far as near the upper surface of the isthmus rhombencephali and can then be followed up (see Figs. 786 and 787) as a poorly defined cross section laterally and dorsally to the nucleus ruber tegmenti (see p. 689), to the ventrolateral nucleus of the thalamus (see also p. 695).

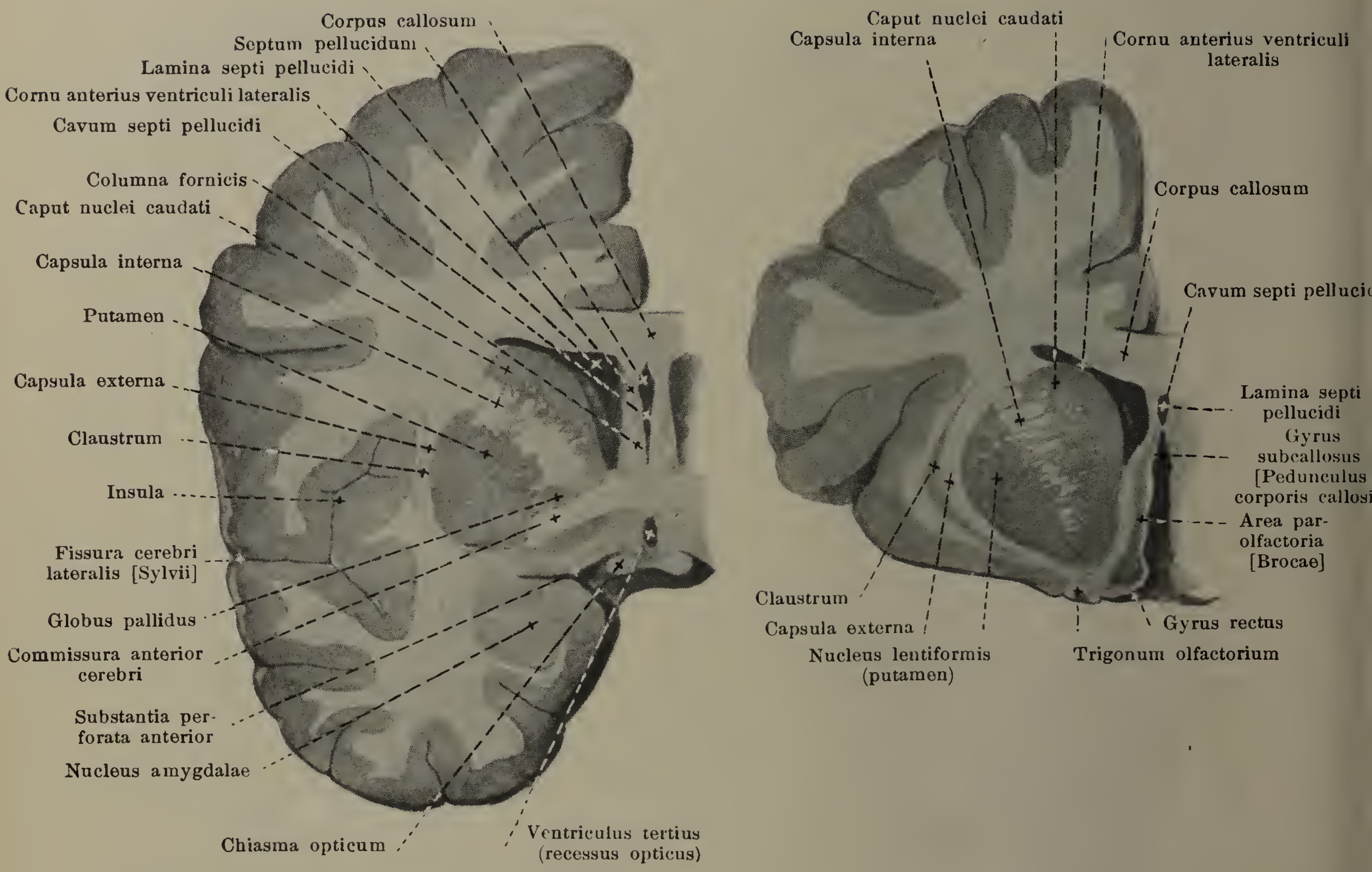
In the region of the *pons* (see Figs. 782—785, 793 and 794) two divisions are to be noted. The larger, ventral one, *pars basilaris pontis,* consists of transverse fibres which run lateralward to the brachia pontis; these fibres contain between them irregular groups of gray matter, *nuclei pontis,* are pierced on each side by the *fasciculi longitudinales [pyramidales],* and thus divided into *fibrae pontis superficiales* and *profundae.* The dorsal division, *pars dorsalis pontis,* extends as far as the rhomboid fossa.

The *cerebellum* (see Figs. 748, 796 and 797) consists also of white and gray matter. The latter covers the whole surface as the *cerebellar cortex (substantia corticalis);* in it, in a fresh or properly hardened preparation, two layers can be made out even with the naked eye, an inner yellowish or reddish-brown layer, *stratum granulosum (granular layer)* and an outer gray layer, *stratum cinereum;* between these two lies the narrow *stratum gangliosum (Purkinje's cells).* In the interior of the cerebellum the white matter forms a continuous mass, *corpus medullare;* this is small in the worm but markedly developed in the hemispheres. From it go off into the interior of the individual lobes *medullary layers, laminae medullares,* which in turn send off secondary and tertiary laminae into the lobules and gyri, so that upon a sagittal median section of the worm (see Fig. 748) a tree-like, much branched figure, *arbor vitae,* is produced. In the corpus medullare lie several gray masses (see Figs. 796 and 797); thus near the worm on each side is the jagged and markedly convoluted *nucleus dentatus,* the *hilus nuclei dentati* of which looks medianward; medial from it is the club-shaped *nucleus emboliformis* (the *cork* or *plug)* and medianward from this one or several *nuclei globosi (spherical nuclei);* in the worm on each side, close to the ventricular cavity, is the *nucleus fastigii (nucleus of the roof)* which is thicker in front and, behind, runs out into several points. The layer of white fibres which passes along the lateral surface of the nucleus dentatus is called the *capsula nuclei dentati.*

A bundle of fibres originating chiefly in the hilus nuclei dentati (see Figs. 797 and 806 and p. 702), the *brachium conjunctivum,* lies at first on the medial side of the fibres of the corpus restiforme which run to the cerebellum (see Figs. 782, 783, 792 and 793) and then (see Figs. 784, 785 and 794) as a bundle bent in cross-section, partly covered by the lemniscus lateràlis, runs converging with the one from the other side to the corpora quadrigemina. Both of the brachia approach each other gradually in their medial and ventral portions and their fibres intersect, ventrally to the corpora quadrigemina *(decussatio brachii conjunctivi)* (see Figs. 785, 797 and 806). From there they run on each side as circular tracts inside the tegmentum [pedunculi] (see Figs. 786, 787, 795 and 808) ventrally to its central gray matter, toward the brain, and soon enlarge through the deposition of gray matter to a spherical body, the *nucleus ruber [tementi] (red nucleus of the tegmentum)* (see Figs. 786, 795, 797 and 801), from the upper end of which they for the most part reach the ventrolateral nucleus of the thalamus (see also p. 702).

In the *mid-brain* (see Figs. 785, 786, 794 and 795) the aquaeductus cerebri is completely surrounded by a gray mass, *stratum griseum centrale,* which is the direct continuation of the gray covering of the floor of the rhomboid fossa. In it lie also the nuclei of origin of the nn. trochlearis and oculomotorius and one nucleus of origin of the motor root of the n. trigeminus (see also Fig. 805). In its ventral part, in the interior of the tegmentum [pedunculi] (see p. 655), lies the spherical gray mass called the *nucleus ruber [tegmenti]* and ventral from this (see above), between the medial lemnicus and the base of the cerebral peduncle, is a larger area, *substantia nigra* (see Figs. 786, 797 and 798), dark colored even to the naked eye owing to its markedly pigmented ganglion cells, it extends upward into the hypothalamus. Dorsalward in the centre of the inferior colliculus is a lenticular gray mass, *nucleus colliculi inferioris* (see Fig. 758), and in the superior colliculus covered by a layer of white matter, *stratum zonale,* is a manifoldly lamellated gray mass, *stratum griseum colliculi superioris* (see Fig. 786).

In the *inter-brain* (see p. 646) in the region of the *hypothalamus,* lying within the corpus mamillare (see Figs. 773 and 798), covered by a layer of white matter, are two gray masses, *nuclei corporis mamillaris.* In these ends partly the columna formicis, and from them runs the *fasciculus thalamomamillaris [Vicq d'Azyri]* (see Figs. 773 and 798) to the nucleus anterior thalami. Directly continuous with the stratum griseum centrale of the mid-brain is a layer of gray matter, *pars grisea hypothalami,* which invests the floor of the third ventricle as far forward as the infundibulum, covering also the medial surface of the hypothalamus and thalamus; it also forms the *massa intermedia* (see p. 666). In the depth lies a special lens-shaped, gray mass, the *nucleus hypothalamicus [corpus Luysi]* (see Figs. 797, 798 and 801), directly in contact with the dorso-medial surface of the base of the cerebral peduncle; it begins approximately in the middle of the nucleus ruber and extends farther rostralward than this. The thalamus contains (see p. 666 and Figs. 773, 798 and 810) several gray nuclie which are partly circumscribed by sharply defined layers of white matter, *laminae medullares thalami;* the largest mass which reaches dorsalward as far as the pulvinar is called the *nucleus lateralis thalami* on which in the depth may be distinguished a *nucleus ventrolateralis [posterior]* and a *nucleus ventrolateralis anterior;* besides this there may be distinguished the *nucleus medialis thalami* and, under the tuberculum anterius, the *nucleus anterior thalami;* in addition, another centrally situated mass is especially striking, usually in the posterior part of the thalamus, the *nucleus centralis (centre médian)* The *corpus geniculatum laterale* (see Fig. 786) and *mediale* (see Figs. 786 and 801) each contains a large nucleus, *nucleus corporis geniculati lateralis* and *medialis;* the *trigonum habenulae* (see Fig. 801) contains a small gray mass, *nucleus habenulae.*

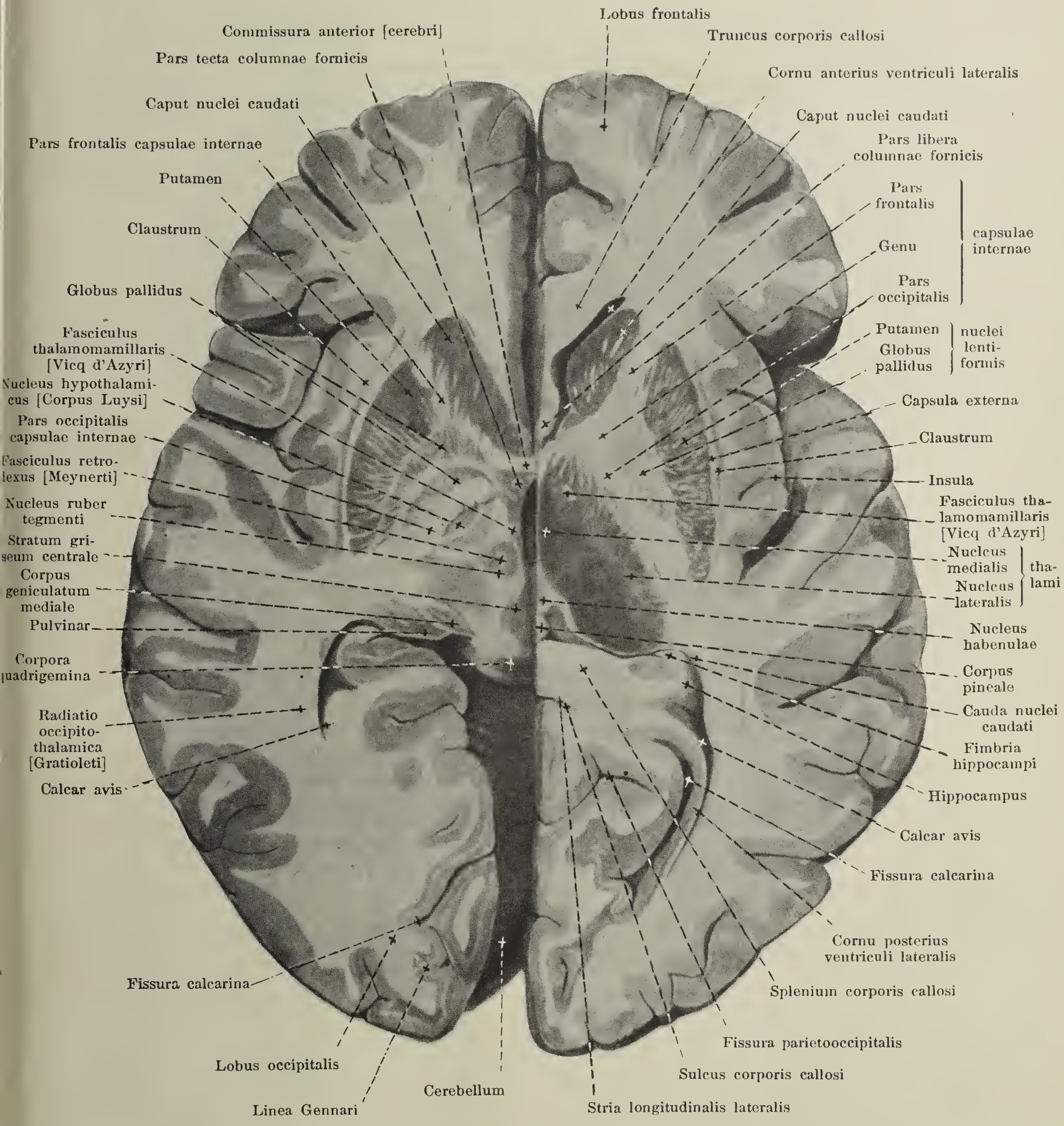


799 and 800. Frontal sections of the brain

left half, viewed from behind,

through the commissura anterior. in front of the commissura anterior.

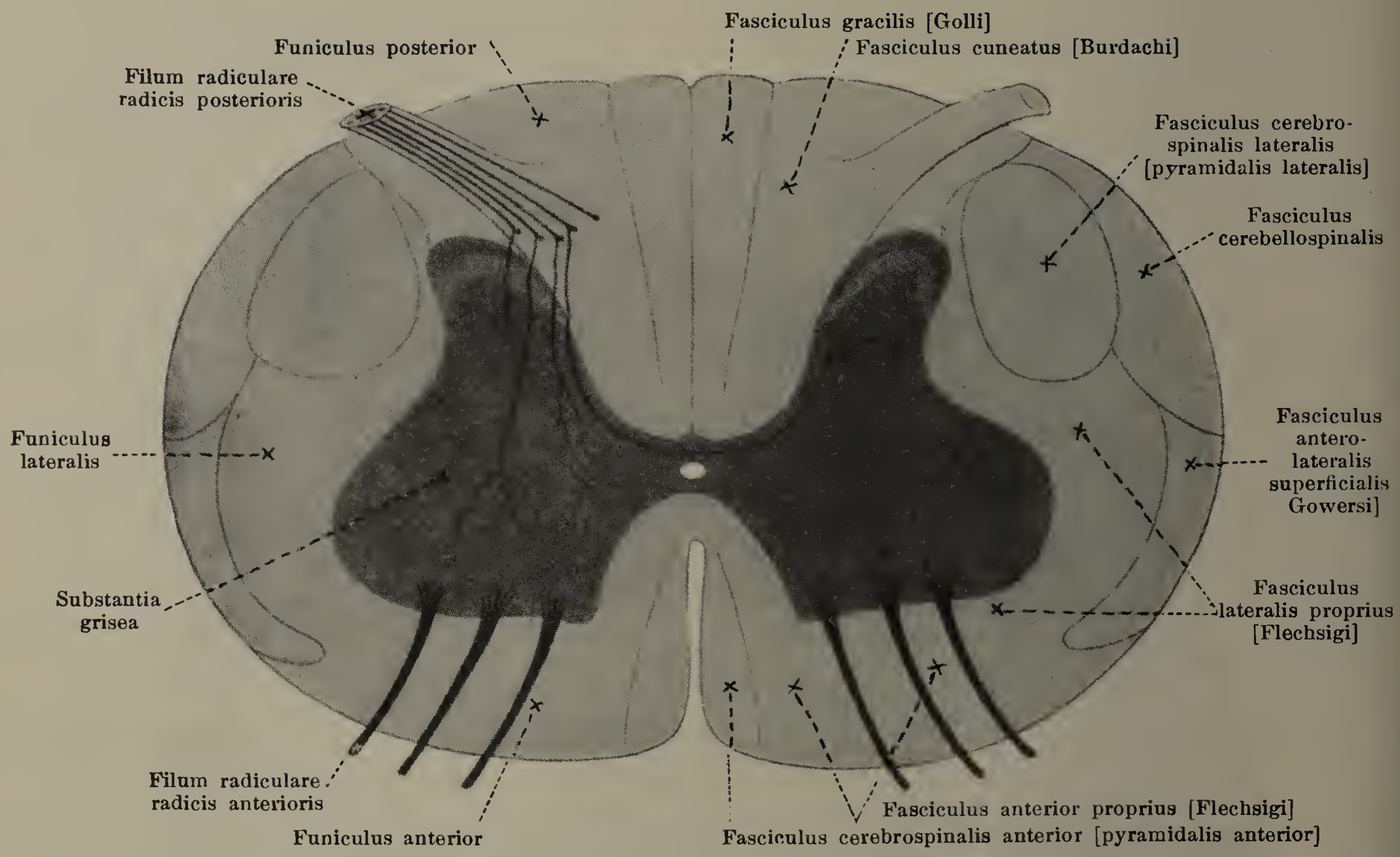
The *cerebral hemisphere* is covered on its whole surface by a layer of gray matter, the *cerebral cortex (substantia corticalis)* (see Figs. 797—801). In the depth, in the neighborhood of the nuclei of the thalamus, lies the gray *corpus striatum,* separated from these and from the cortex by layers of white matter; it is divided itself by masses of white fibres *(capsula interna,* see below) into a medial part, the *nucleus caudatus* (see p. 671 and Figs. 769, 771, 773 and 798—801), bordering on the cavity of the lateral ventricle, and a lateral part, the *nucleus lentiformis* (see Figs. 769, 771, 773 and 797—801), buried in the interior. The latter lies also laterally of the thalamus and is wedge-shaped. It does not reach so far forward as the nucleus caudatus nor backward nearly so far as the thalamus, it is divided in to three parts by two thin medullary layers, concentric with the convex lateral surface. Of the parts of the nucleus lentiformis, the medial and middle portions together, pale and like the adjacent thalamus, are called the *globus pallidus,* while the lateral largest part, *putamen,* is colored dark-gray like the nucleus caudatus; putamen and nucleus caudatus are partly connected with each other in their frontal portions (see Figs. 771 and 797—801). The medial boundary of the lentiform nucleus (see Figs. 769 and 798—801) is formed by a broad mass of white matter, *capsula interna.* This is bent at an angle (see Fig. 801) and is subdivisible into a *pars frontalis capsulae internae* between the nucleus caudatus and the lentiform nucleus, a *genu capsulae internae,* and a *pars occipitalis capsulae internae* between the thalamus and the nucleus lentiformis. It is separated by a thin medullary layer, *capsula externa,* from a narrow layer of gray matter, *claustrum (bulwark);* the medial surface of this is smooth but its lateral surface presents small projections corresponding to the gyri of the island. The claustrum is separated from the cortex of the island by a further layer of white matter.



801. Horizontal section through the brain,
viewed from above.
(In the left half of the figure the plane of the section is about 1 cm deeper than in the right.)

In the most anterior part of the temporal lobe lies a large gray mass, *nucleus amygdalae, almond nucleus* (see Fig. 799), which is continuous medianward with the cortex of the gyrus hippocampi and dorsalward with the lentiform nucleus.

The gray masses which surround directly the cavities in the interior of the brain and of the medulla oblongata are collectively called the *central gray matter* (see also p. 689).


Fasciculus gracilis [Golli]
Funiculus posterior
Fasciculus cuneatus [Burdachi]
Filum radiculare radicis posterioris
Fasciculus cerebrospinalis lateralis [pyramidalis lateralis]
Fasciculus cerebellospinalis
Funiculus lateralis
Fasciculus anterolateralis superficialis [Gowersi]
Substantia grisea
Fasciculus lateralis proprius [Flechsigi]
Filum radiculare radicis anterioris
Funiculus anterior
Fasciculus anterior proprius [Flechsigi]
Fasciculus cerebrospinalis anterior [pyramidalis anterior]

802. Schematic transverse section of the spinal cord with the chief conduction paths.

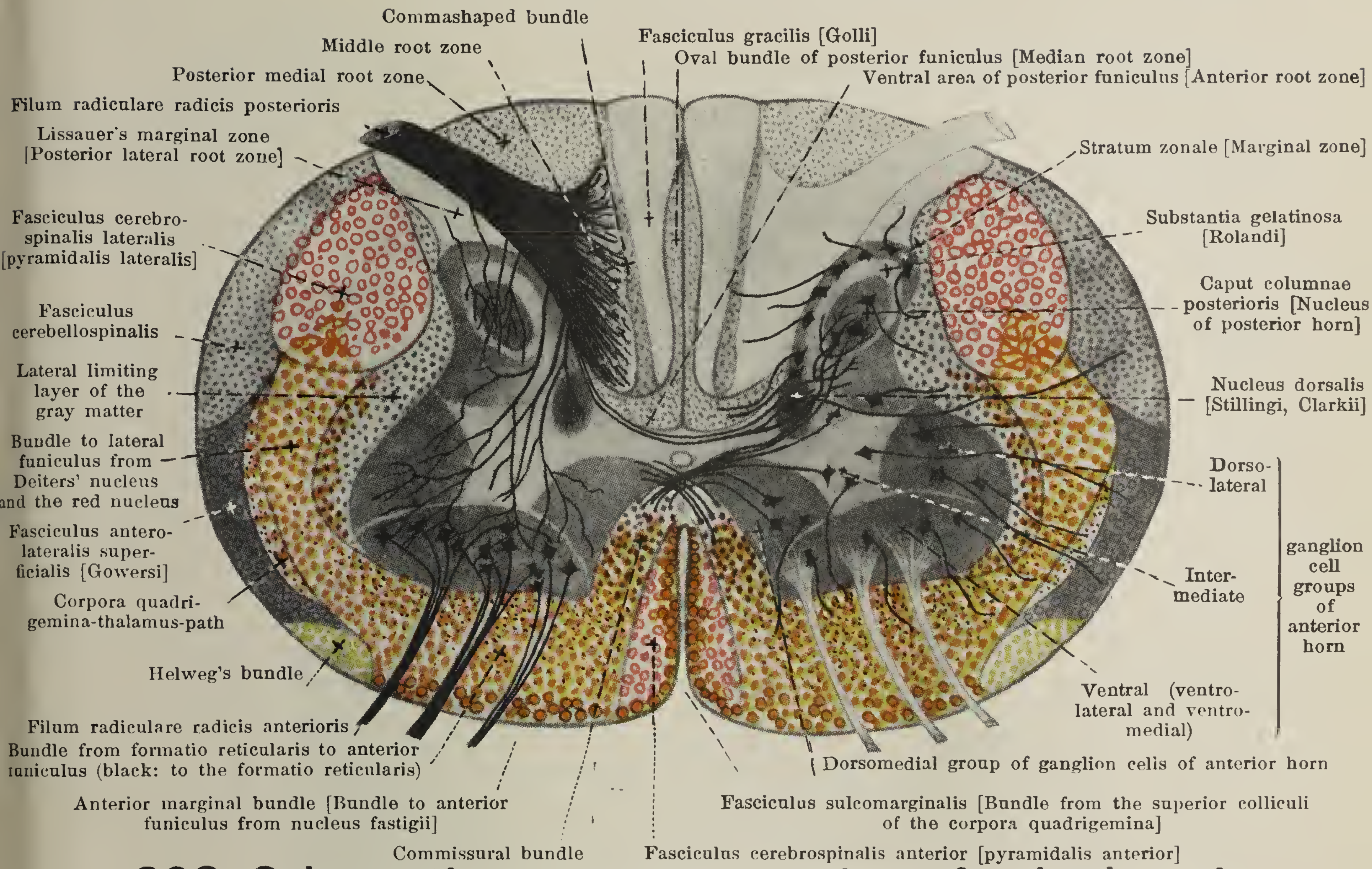
Magnification: ca. 12.5:1.

(The lateral strands are drawn darker than the anterior and posterior strands.)

The sum of the fibres which arise from the cortex of the brain (or end there) and converge fanshaped toward the interbrain forms the so-called *corona radiata* (Fig. 798); they run to the gray matters of the interbrain or further caudalward to the mid-brain, hind-brain, and medulla (see p. 702). According to the relation of the fibres to the various areas of the brain, we distinguish in the corona radiata, a *pars frontalis*, *pars parietalis*, *pars temporalis*, and *pars occipitalis*. The fibres of the capsula interna and capsula externa, which pass into the corona radiata at the upper border of the lenticular nucleus, are designated as *radiatio corporis striati* (see Fig. 798).

The medullary substance of each cerebral hemisphere attains its greatest development above the corpus striatum; on horizontal cross-section at the level of the upper surface of the corpus callosum it appears as a large white field, *centrum semiovale* (see Fig. 768), surrounded on all sides by a coat of gray matter. It contains besides the fibres from the corona radiata and association fibres (see p. 702), also the fibres from the corpus callosum *(radiatio corporis callosi)* (see Figs. 768 and 798). These radiations from the corpus callosum first run horizontally, but later ascend or descend, as the case may be, to the upper or lower parts of the brain. The fibres running forward from the knee of the corpus callosum and arching laterally to the frontal lobe are known as the *pars frontalis* of the *radiatio corporis callosi*, those running sideways to the parietal lobe, as *pars parietalis*. Other fibres from the corpus callosum running backward in a laterally convex arch form the *pars occipitalis;* still others in the temporal region, the *pars temporalis;* these fibres spread over the white layer, or *tapetum*, covering the posterior and inferior horns.

The corpus callosum is the strongest band of fibres, or *commissures*, which connect the two cerebral hemispheres with each other. The *commissura anterior [cerebri]* (see p. 666 and Figs. 748, 761, 771, 797, 799 and 801) runs transversely as a strong fibre bundle over the substantia perforata anterior behind the lamina terminalis and in front of the limbs of the fornix; its chief mass *(pars posterior)* curves downward and backward and runs at the base of the lenticular nucleus to the caudal part of the temporal lobe; a small part *(pars anterior)* runs to the lobus olfactorius. The *commissura hippocampi* (see p. 670) consists chiefly of fibres which run from one hippocampus to the other.


Commashaped bundle
Middle root zone
Posterior medial root zone
Filum radiculare radicis posterioris
Lissauer's marginal zone [Posterior lateral root zone]
Fasciculus cerebrospinalis lateralis [pyramidalis lateralis]
Fasciculus cerebellospinalis
Lateral limiting layer of the gray matter
Bundle to lateral funiculus from Deiters' nucleus and the red nucleus
Fasciculus anterolateralis superficialis [Gowersi]
Corpora quadrigemina-thalamus-path
Helweg's bundle
Filum radiculare radicis anterioris
Bundle from formatio reticularis to anterior funiculus (black: to the formatio reticularis)
Anterior marginal bundle [Bundle to anterior funiculus from nucleus fastigii]
Commissural bundle
Fasciculus cerebrospinalis anterior [pyramidalis anterior]
Fasciculus sulcomarginalis [Bundle from the superior colliculi of the corpora quadrigemina]
Dorsomedial group of ganglion cells of anterior horn
Ventral (ventrolateral and ventromedial)
Intermediate
Dorsolateral
ganglion cell groups of anterior horn
Nucleus dorsalis [Stillingi, Clarkii]
Caput columnae posterioris [Nucleus of posterior horn]
Substantia gelatinosa [Rolandi]
Stratum zonale [Marginal zone]
Ventral area of posterior funiculus [Anterior root zone]
Oval bundle of posterior funiculus [Median root zone]
Fasciculus gracilis [Golli]

803. Schematic transverse section of spinal cord with conduction paths and groups of ganglion cells. Magnification: circa 12.5 : 1. (Held.)

(All the paths descending from the brain to the spinal cord are in colors, all other paths in the spinal cord, ascending and descending, are indicated in black.)

Brief resumé of the conduction paths of the spinal cord with synonyms. (Held.)

Funiculus posterior.

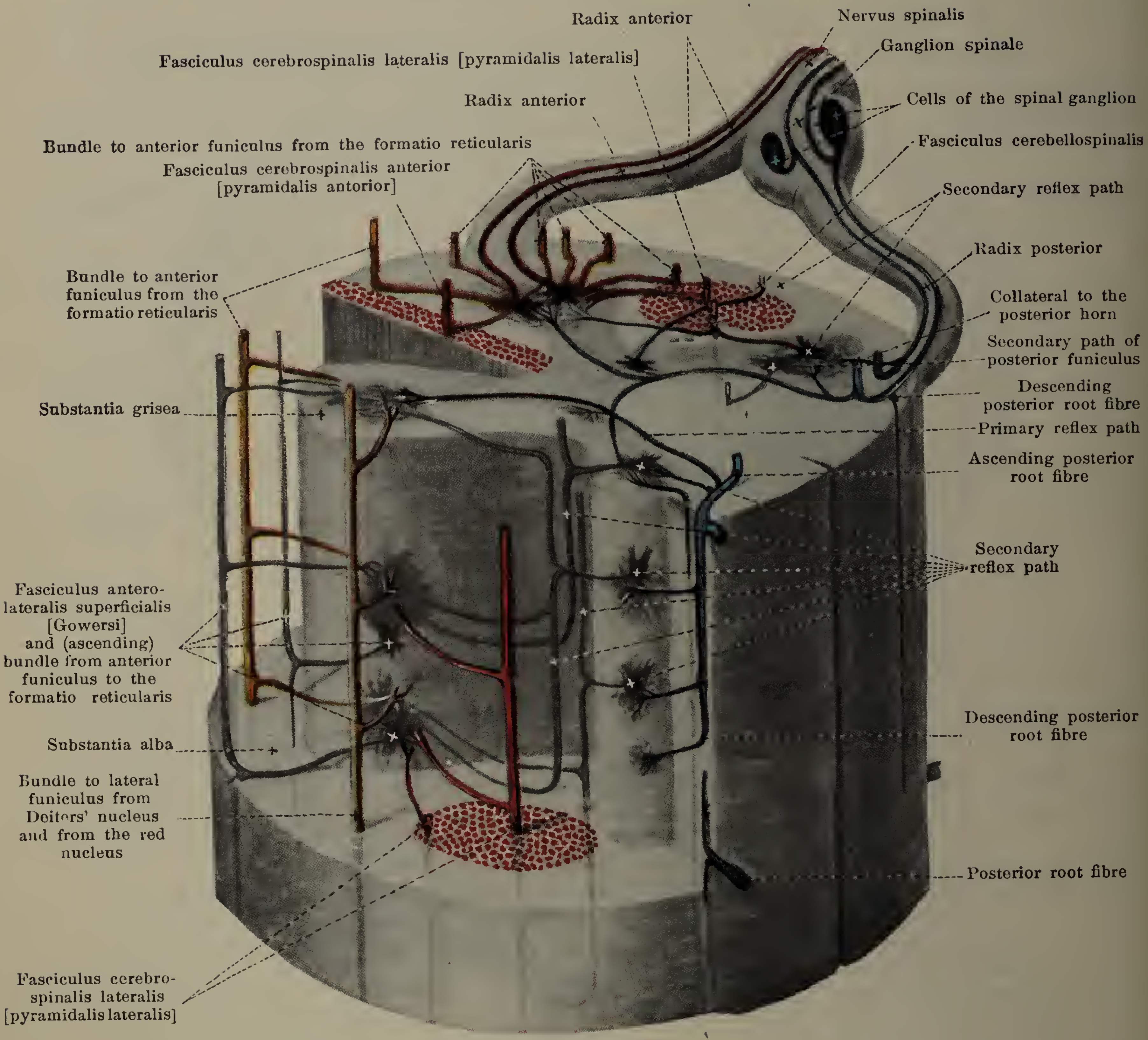
Oval bundle of posterior funiculus = median root zone.
Fasciculus gracilis [Golli] = Goll's tract.
Ventral area of posterior funiculus = anterior root zone
Comma-shaped bundle
Middle root zone
Posterior medial root zone
} Fasciculus cuneatus [Burdachi] = Burdach's fasciculus.
Lissauer's marginal zone = posterior lateral root zone.

Funiculus lateralis.

Fasciculus cerebrospinalis lateralis [pyramidalis lateralis] = lateral pyramidal tract.
Fasciculus cerebellospinalis = direct cerebellar tract.
Fasciculus anterolateralis superficialis [Gowersi] = Gowers' tract = cerebellar tract of anterolateral funiculus.
Lateral limiting layer of the gray matter
Bundle to lateral funiculus from Deiters' nucleus and from the red nucleus
Corpora quadrigemina-thalamus-path
Helwegs' bundle
} Fasciculus lateralis proprius [Flechsigi] = ground bundle of lateral funiculus.

Funiculus anterior.

Bundle to anterior funiculus from formatio reticularis (partly also to the formatio reticularis)
Anterior marginal bundle = bundle to anterior funiculus from the nucleus fastigii (roof-nucleus)
Commissural bundle
} Fasciculus anterior proprius [Flechsigi] = ground bundle of anterior funiculus.
Fasciculus cerebrospinalis anterior [pyramidalis anterior] = anterior pyramidal tract.
Fasciculus sulcomarginalis = path from corpora quadrigemina to anterior funiculus.


Radix anterior
Nervus spinalis
Ganglion spinale
Fasciculus cerebrospinalis lateralis [pyramidalis lateralis]
Radix anterior
Cells of the spinal ganglion
Bundle to anterior funiculus from the formatio reticularis
Fasciculus cerebellospinalis
Fasciculus cerebrospinalis anterior [pyramidalis antorior]
Secondary reflex path
Radix posterior
Bundle to anterior funiculus from the formatio reticularis
Collateral to the posterior horn
Secondary path of posterior funiculus
Descending posterior root fibre
Substantia grisea
Primary reflex path
Ascending posterior root fibre
Secondary reflex path
Fasciculus antero-lateralis superficialis [Gowersi] and (ascending) bundle from anterior funiculus to the formatio reticularis
Descending posterior root fibre
Substantia alba
Bundle to lateral funiculus from Deiters' nucleus and from the red nucleus
Posterior root fibre
Fasciculus cerebro-spinalis lateralis [pyramidalis lateralis]

804. The most important relations of the nerve-elements of the spinal cord in transverse and longitudinal section, schematic. Magnification: circa 10 : 1. (Held.)

(A part of the gray matter has been exposed on the left side in a piece of spinal cord. The nerve fibres have been drawn in as rigid tubes and the cells have been introduced in the gray matter [supposedly transparent]. The spinal cord is viewed from the left and behind.)

Motor anterior roots red; posterior roots from the spinal ganglion blue; colors otherwise the same as in Fig. 803.)

Conduction paths of the spinal cord (see also Fig.803). (Held). ***Cross-section relations of the posterior roots:*** to the posterior horn of the same and of the opposite side, to Clarke's column and to the anterior horn *(reflex bundle of the sensory roots of the spinal cord).*

The ***funiculi of the spinal cord*** are derived, aside from the areas of the posterior funiculus which come from the limbs of bifurcation of the posterior roots themselves, from the different *funicular cells of the gray matter* (see their arrangement also in Fig. 803), or they are the *continuations of conduction paths,* the origins of which are situated above the spinal cord in the brain-stem, cerebellum or cerebrum.

All funiculi of the spinal cord have, by means of their collaterals, cross-section relations with the gray matter of the spinal cord and its cell-groups.

The **origin of the conduction paths descending to the spinal cord** (indicated in colors in Fig. 803) is as follows: ***the pyramidal tract*** (red) comes from the anterior central gyrus (of the same and of the opposite side, decussation of pyramids see Figs. 778 and 807); the ***anterior marginal bundle*** comes from the roof-nucleus (nucleus fastigii) (see Fig. 796), perhaps also from other gray masses of the cerebellum (of the same and of the opposite side). The ***fasciculus sulcomarginalis*** arises as the *optic-acoustic reflex path* (see also p. 698) in the middle gray matter of the superior colliculus (see Fig. 795), in largest part crosses in the *dorsal decussation of the tegmentum* (see Figs. 786 and 795) and then passes into the brain-stem in the *fasciculus longitudinalis medialis* (O. T. *posterior longitudinal bundle)* (see Figs. 778—785 and 788—794) downward to the spinal cord; individual fibres in the more lateral areas of the anterior and lateral funiculi (not designated) have the same origin. The origin of the orange-colored area is in three places: 1. In Deiters' nucleus (nucleus n. vestibularis lateralis) (see Figs. 791 and 805) of the same side; this system passes as the *bundle of the lateral funiculus from Deiters' nucleus* obliquely through the formatio reticularis (see Figs. 782, 791 and 792) and runs through the medulla oblongata in the area occupied by Gowers' tract (see Figs. 778—781 and 788—790). 2. In the red nucleus of the tegmentum (nucleus ruber tegmenti) of the opposite side; this bundle goes through the *ventral decussation of the tegmentum* (see Fig. 795) into the lateral lemniscus of the opposite side (see Figs. 784 and 794), then perforates the trapezoid body (corpus trapezoideum) (see Figs. 782, 783, 792 and 793) and as the *bundle of the lateral funiculus from the red nucleus* joins that from Deiters' nucleus (see Figs. 781—783 and 790—793). 3. In the three lateral nuclei of the formatio reticularis (nucleus lateralis inferior see Figs. 780 and 781, medius see Fig. 783, superior see Fig. 786); its fibres lie in large part in the *fasciculus longitudinalis medialis* (O. T. posterior longitudinal bundle), in part also in the longitudinal strands of the formatio reticularis (substantia reticularis alba) (see Fig. 778—786 and 788—795).

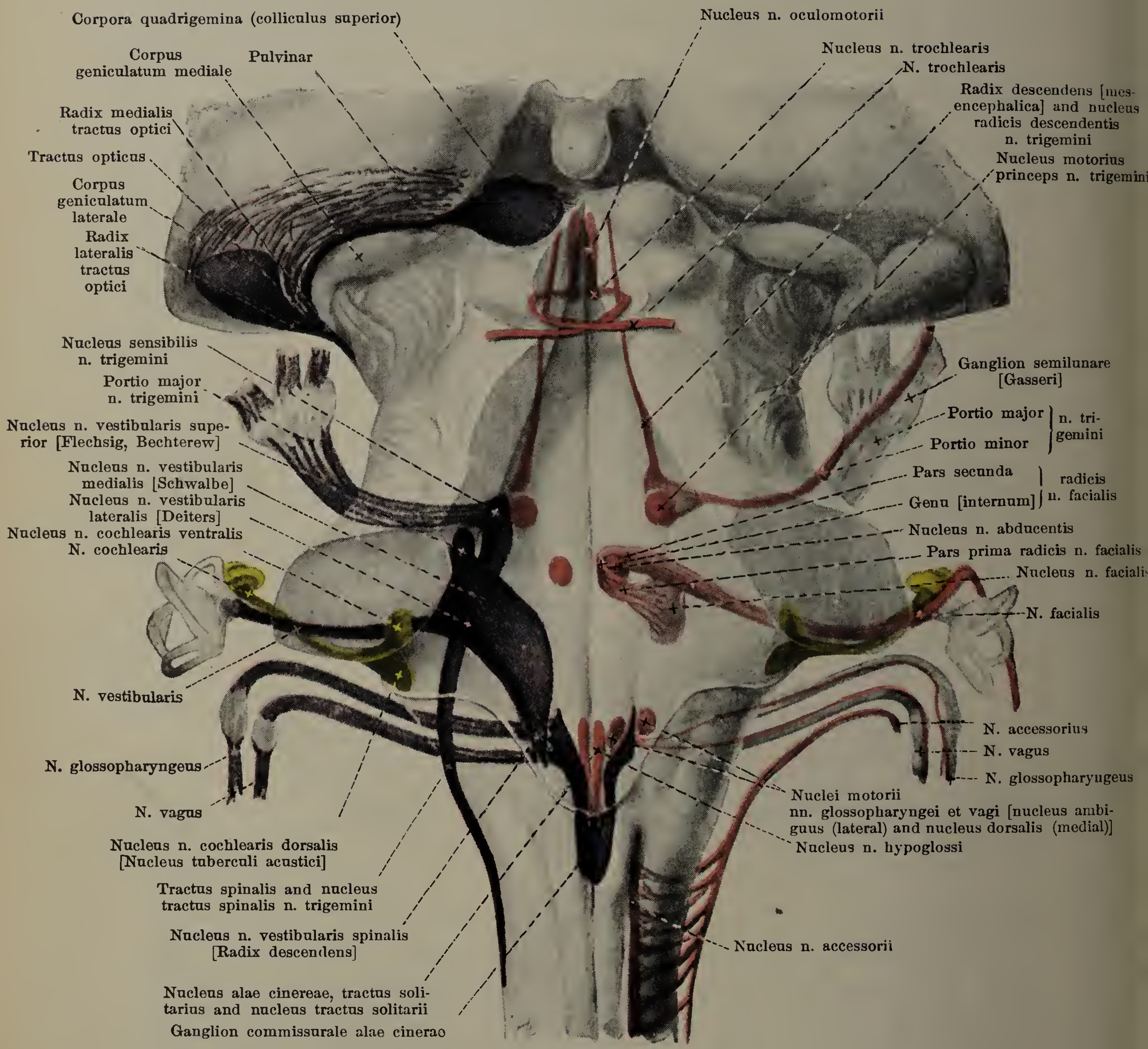
The *other descending conduction paths in the spinal cord* come from three sources: 1. From the posterior roots (origin: spinal ganglia); these lie partly in *Lissauer's marginal zone,* partly in the *middle root zone.* 2. From the cells of the posterior horn (stratum zonale see Fig. 803); these run partly in the *comma-shaped bundle,* in the *ventral area of the posterior funiculus* and in the *lateral limiting layer of the gray matter,* partly also in *Lissauer's marginal zone.* 3. From the cells of the anterior horn; these lie partly in the anterior, partly in the lateral funiculi.

The **ascending systems of the spinal cord** (see Figs. 803 and 804) are the following three:

1. ***Direct continuation of the posterior roots;*** these run in the posterior funiculus to the nucleus fasciculi gracilis and nucleus fasciculi cuneati. Their *secondary path* arising here, crosses in the *sensory (fillet) decussation (decussatio lemniscorum)* (see p. 687 and Figs. 779 and 788) and goes as the *interolivary layer (stratum interolivare lemnisci)* and *medial fillet (lemniscus medialis [sensitivus])* to the ventrolateral nucleus of the thalamus, partly directly to the somaesthetic area (see Figs. 779—786, 789—795 and 806—812) and crossed and uncrossed partly by way of the fibrae arcuatae externae and in the path of the corpus restiforme (see p. 700) to the nucleus dentatus and worm of the cerebellum (see Figs. 789—792).

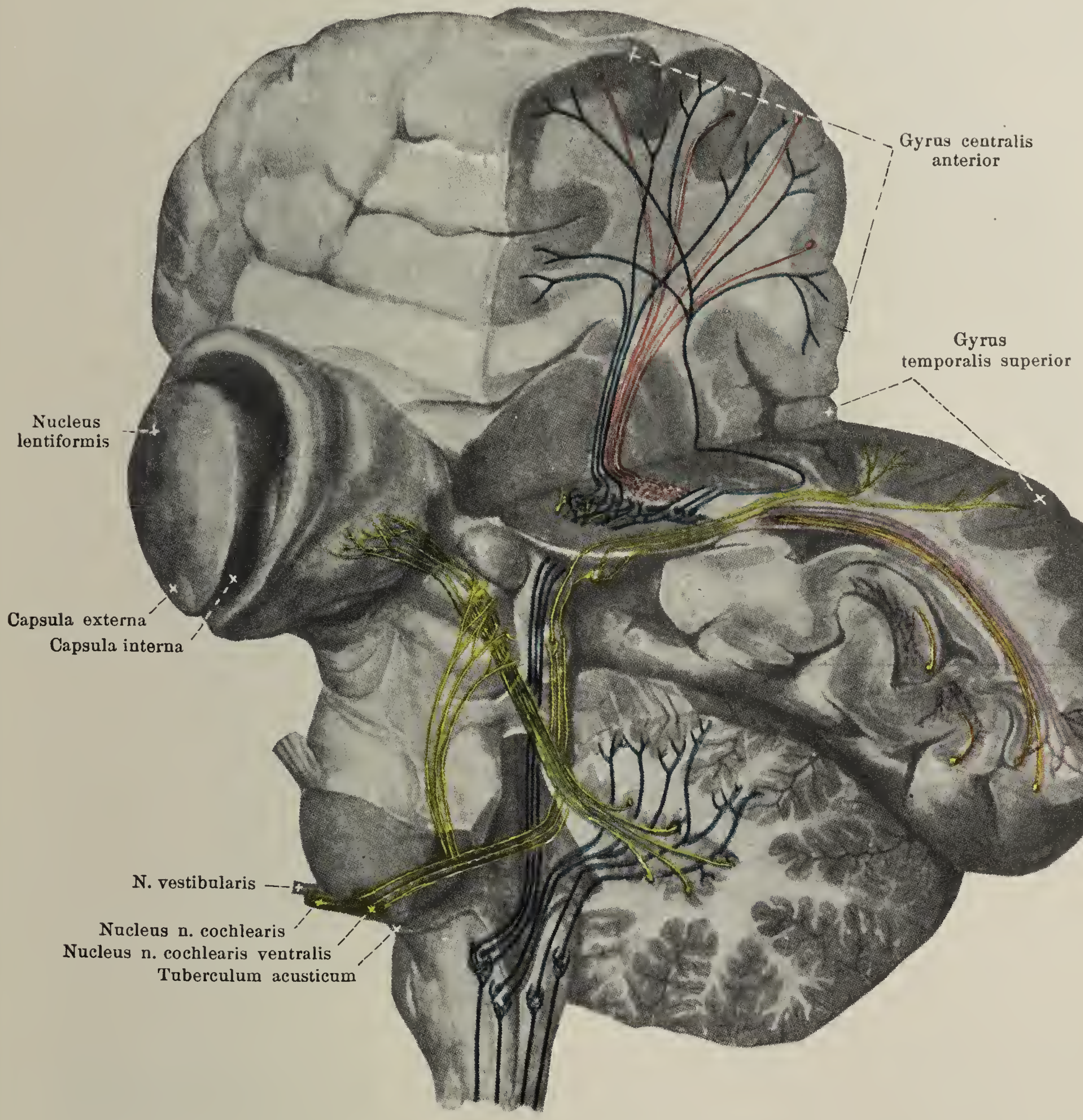
2. The ***conduction paths superimposed upon this primary sensory path of the posterior funiculus*** are derived from the cells of the posterior horn, of Clarke's column, and also, partly, of the anterior horn, around which collaterals of the posterior roots break up. The conduction paths arising from the posterior horn go partly into the posterior funiculus of the same side and into the lateral funiculus of the same side *(lateral limiting layer of the gray matter),* partly also into the opposite anterior funiculus (by way of the *anterior white commissure).* The cells of Clarke's nucleus send their axones by way of the homolateral *direct cerebellar tract, fasciculus cerebellospinalis,* (contained above in the corpus restiforme) (see Figs. 778—783 and 788—792) to the cortex of the upper surface of the worm. The anterior horn cells concerned send their axis-cylinder-processes probably in the area of the homolateral *Gowers' tract (fasciculus anterolateralis superficialis [Gowersi], cerebellar path of anterolateral funiculus)* (see Figs. 778—784 and 788—793) to the inferior surface of the worm and into the *commissural bundle* whence their course and end is unknown.

3. The ***conduction paths arising from the anterior horn cells*** are partly short, running in the ground bundles of the anterior and lateral funiculi and then bend back into the gray matter, partly long, extending upward as far as the formatio reticularis to end in an unknown manner.


Corpora quadrigemina (colliculus superior)
Corpus geniculatum mediale
Pulvinar
Radix medialis tractus optici
Tractus opticus
Corpus geniculatum laterale
Radix lateralis tractus optici
Nucleus sensibilis n. trigemini
Portio major n. trigemini
Nucleus n. vestibularis superior [Flechsig, Bechterew]
Nucleus n. vestibularis medialis [Schwalbe]
Nucleus n. vestibularis lateralis [Deiters]
Nucleus n. cochlearis ventralis
N. cochlearis
N. vestibularis
N. glossopharyngeus
N. vagus
Nucleus n. cochlearis dorsalis [Nucleus tuberculi acustici]
Tractus spinalis and nucleus tractus spinalis n. trigemini
Nucleus n. vestibularis spinalis [Radix descendens]
Nucleus alae cinereae, tractus solitarius and nucleus tractus solitarii
Ganglion commissurale alae cinerae
Nucleus n. oculomotorii
Nucleus n. trochlearis
N. trochlearis
Radix descendens [mes-encephalica] and nucleus radicis descendentis n. trigemini
Nucleus motorius princeps n. trigemini
Ganglion semilunare [Gasseri]
Portio major
Portio minor
n. trigemini
Pars secunda
Genu [internum]
radicis n. facialis
Nucleus n. abducentis
Pars prima radicis n. facialis
Nucleus n. faciali
N. facialis
N. accessorius
N. vagus
N. glossopharyngeus
Nuclei motorii nn. glossopharyngei et vagi [nucleus ambiguus (lateral) and nucleus dorsalis (medial)]
Nucleus n. hypoglossi
Nucleus n. accessorii

805. Nuclei of origin of motor and primary terminal nuclei of sensory cerebral nerves, schematically represented in a supposedly transparent brain-stem, viewed from behind (see also Figs. 751 and 757). Magnification: 2:1. (Held.)

(Nuclei and roots of motor nerves red, of sensory reddish-violet, of the n. cochlearis yellow and of the n. opticus bluish-violet.)



806. Course of some of the greater conduction paths in the brain (see also Figs. 807 and 808). (Held.)

On the left side the cerebellum has been completely removed as well as the cerebrum with the exception of the large ganglia; on the right side the posterior superior part of the cerebral hemisphere has been removed by a vertical (not exactly frontal) and a horizontal section.

The brain is viewed from the left and from behind.

Pyramidal tract red; **path from the ventrolateral nucleus of the thalamus to the somaesthetic area** blue; **posterior funiculi, nuclei of posterior funiculi** and further portions of the same conduction paths, viz.: 1. **medial lemniscus** (crossed) to the ventrolateral nucleus of the thalamus, 2. part of the **corpus restiforme** (of the same and of the opposite side) to the nucleus dentatus and to the cortex of the vermis blue; **cochlear nerve** and **auditory conduction path** yellow; **primary** (corticopetal) **optic radiation** violet, **secondary** (corticofugal) orange; **brachium conjunctivum** green.

Origin and central conduction paths of the cerebral nerves. (Held.)

The **motor cerebral nerves** arise in definite gray masses of the brain-stem, their so-called *nuclei of origin (nuclei originis).* On the other hand, the gray masses in which the **sensory cerebral nerves** first enter and branch up (nuclei of the sensory nerves) are their *terminal nuclei* or their primary domains of termination, while their origin must be sought in their ganglia situated outside the brain. The *secondary paths* proceed from the primary terminal nuclei.

1. The **nervus olfactorius** arises in the bipolar olfactory cells of the regio olfactoria of the nasal mucous membrane; its primary domain of termination lies in the olfactory glomeruli of the bulbus olfactorius. From this a secondary path proceeds from the mitral cells and forms the nerve fibres of the *tractus olfactorius* (see p. 665). A part of the latter ends in the cortex of the trigonum olfactorium; a second part, the *lateral olfactory root (stria olfactoria lateralis),* runs to the uncus, whence further paths go to the hippocampus, the gyrus hippocampi and the half of the gyrus fornicatus adjoining the corpus callosum. The *intermediary root (stria olfactoria intermedia)* penetrates into the substantia perforata anterior and the *medial olfactory root (stria olfactoria medialis)* passes to the gyrus subcallosus. These domains of termination in the cortex form together the *olfactory sphere* (see Fig. 801).

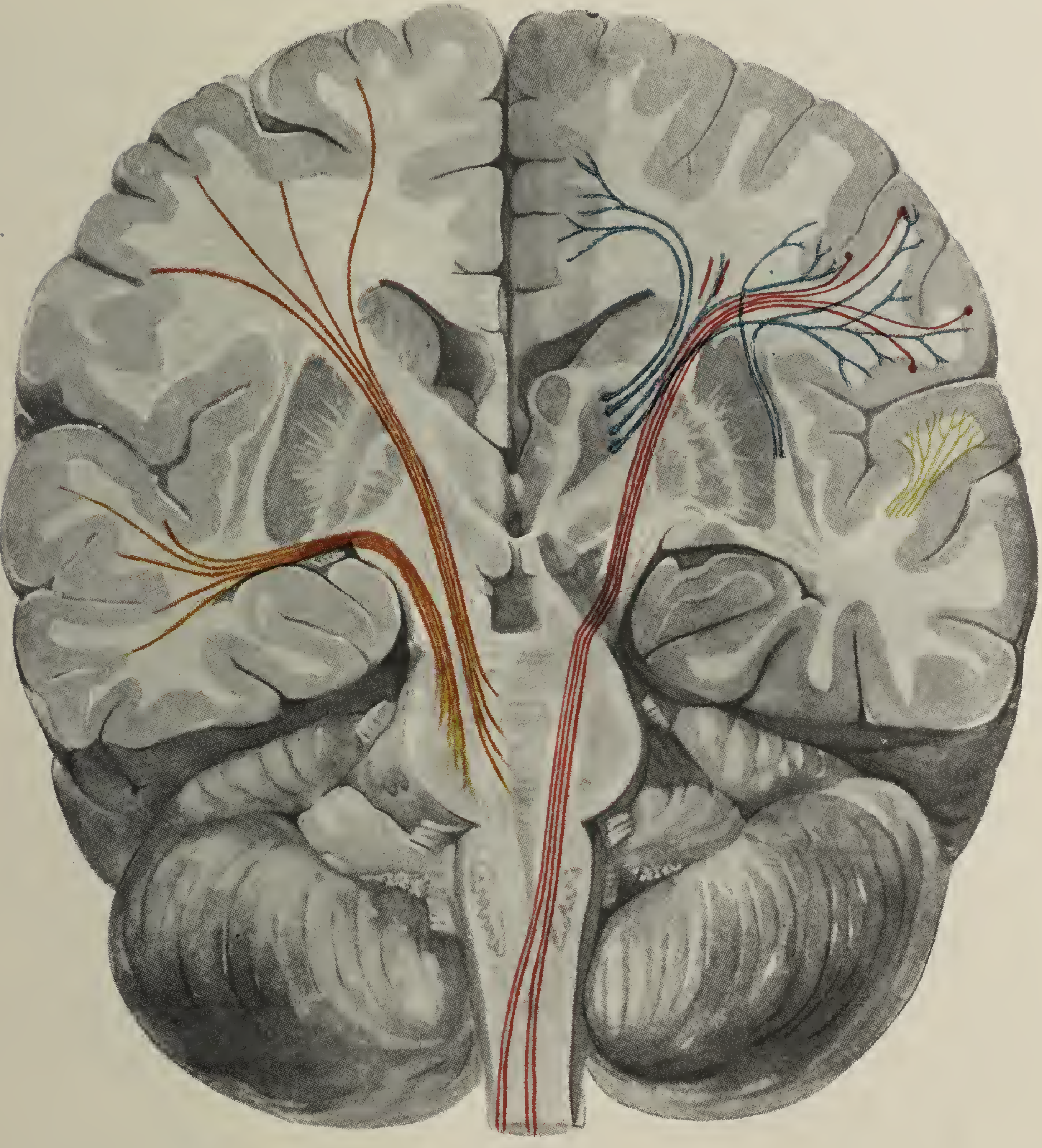
2. The sensory cells of the retina are connected by the bipolar nerve cells of the innner granular layer with the large ganglion cells of the retina; from these arises the **nervus opticus,** which undergoes partial decussation with the optic nerve of the other side in the *chiasma opticum,* whereby the largest part (from the nasal half of the retina) passes into the opposite tractus opticus, a smaller part (from the temporal side of the retina) into the tractus of the same side. The tractus opticus, which therefore contains nerve fibres from both retinae, ends in the corpus geniculatum laterale and in the pulvinar thalami as well as in the superficial and middle gray matter of the superior colliculus (see Figs. 786 and 805). The corticopetal *primary optic radiation* runs from the geniculate body and thalamus in the *radiatio occipito-thalamica [Gratioleti]* occipitalward along the posterior horn of the lateral ventricle (separated from it by the tapetum) to the visual sphere lying around he fissura calcarina and characterized by the linea Gennari (see Figs. 801, 806 and 808—812). Fibres run also in the opposite direction (corticofugal) from the visual sphere to the superior colliculus of the corpora quadrigemina *(secondary optic radiation).* In the middle gray matter of the superior colliculus arises the *optic-acoustic reflex path* (see p. 695), innervates the nuclei of the nn. oculomotorius, trochlearis and abducens and descends to the spinal cord (see Figs. 778—786 and 788—795).

3. The **nervus oculomotorius** arises in the *nucleus n. oculomotorii,* which lies in the floor of the substantia grisea centralis at the level of the superior colliculus (see Figs. 786, 795 and 805). The ganglion cell-groups lying in the dorsal trough of the fasciculus longitudinalis medialis form the lateral nucleus, which especially innervates the extrinsic muscles of the eye. A small part of the n. oculomotorius crossing the middle line between the two nuclei arises from the distal portion of the nucleus of the other side. From the cortex of the central gyri the oculomotorius nucleus, like that of the n. trochlearis, in all probobility receives voluntary innervation; the path passes through the base of the cerebral peduncle.

4. The **nervus trochlearis** arises from the *nucleus n. trochlearis* situated just caudalward to the previous nucleus (see Fig. 785); it passes dorsalward at the margin of the central gray matter and undergoes total decussation in the velum medullare anterius *(decussatio nervorum trochlearium)* (see Figs. 794 and 805).

5. **N. trigeminus** (see Fig. 805). The motor *portio minor* arises from the *nucleus motorius princeps n. trigemini,* the *locus caeruleus* and the cell column *(nucleus radicis descendentis)* accompanying the *radix descendens [mesencephalica] n. trigemini,* which reaches upward at the margin of the central gray matter almost as far as the level of the commissura posterior (see Figs. 783—785, 793 and 794). The sensory *portio major* arises from the *ganglion semilunare [Gasseri],* perforates the pons and, bifurcating, ends partly in the *nucleus sensibilis n. trigemini,* partly descending as the *tractus spinalis n. trigemini* in the gray mass *(nucleus tractus spinalis)* adjacent to it (see Figs. 778—783, 788—792 and 796). From the sensory trigeminus nucleus a reflex path passes to the motor trigeminus nucleus of the same and of the opposite side; upon these also collaterals of the radix descendens influence. Similarly a path to this motor nucleus of origin arises from the nucleus tractus spinalis n. trigemini by way of the fibrae arcuatae internae at the level of the facial nucleus. In addition secondary cortical paths extend from the terminal nucleus of the tractus spinalis partly in the crossed interolivary layer, partly in fields of the formatio reticularis of the same and of the opposite sides; they finally, through intercalation of the ventrolateral nucleus of the thalamus, become connected with the cortex of the somaesthetic area. The voluntary cortical path for the motor nucleus of the n. trigeminus runs in part in the pyramidal tract; it arises in the inferior third of the anterior central gyrus and in the feet of the frontal gyri in front of it (see Fig. 811).

6. **N. abducens.** It arises from the *nucleus n. abducentis,* which lies just in front of the genu [internum] radicis n. facialis on the floor of the fourth ventricle (see Figs. 782, 792 and 805). The cortical path for its voluntary innervation is probably the pyramidal tract.



807. Course of the pyramidal tract (red) and of the cerebropontile paths (temporal: light-brown; frontal: dark-brown); end of auditory conduction path (yellow) and indirect continuation of medial lemniscus and brachium conjunctivum from the ventrolateral nucleus of the thalamus (blue), introduced into Fig. 798. (Held.)

7. **N. facialis** (see Figs. 782, 791, 792 and 805). Its nucleus of origin, *nucleus n. facialis,* lies in the ventral part of the formatio reticularis at about the middle of the dorsoventral diameter of the pons. It is innervated by the lower third of the anterior central gyrus (see Fig. 811) by way of the pyramidal tract, which gives off arcuate fibres, partly to the nucleus of the same side, partly to that of the opposite side, through the raphe of the medulla oblongata. The *radix n. facialis* at first passes *(pars prima)* dorsal- and medianward as far as the floor of the rhomboid fossa, there loops in front of the colliculus facialis with a sharp bent *(genu [internum])* around the nucleus of the n. abducens and then *(pars secunda)* goes ventral- and lateralward to the site of emergence.

The central connections of the *n. intermedius* have been insufficiently worked out in man.

8. **N. acusticus.** It consists of the *n. vestibularis* and the *n. cochlearis* (see Fig. 805).

a) The *n. vestibularis* arises in the *ganglion vestibulare;* its central root ends in the region of the floor of the rhomboid fossa in the *nucleus nervi vestibularis lateralis [Deiters], nucleus medialis [Schwalbe]* and *nucleus superior [Flechsig, Bechterew]* (see Figs. 780—782, 791, 792 and 796). Another part passes downward as the *radix descendens* and ends in the gray mass accompanying it *(nucleus n. vestibularis spinalis)* (see Figs. 780, 781, 789 and 790). Reflex paths pass from Deiters' nucleus to the lateral funiculus of the spinal cord, from the medial and superior nuclei to the fasciculus longitudinalis medialis of both sides, a part, after innervation of the nucleus n. abducentis of the same side passing to the nucleus n. trochlearis and nucleus n. oculomotorii of the opposite side. Farther, fibrae arcuatae internae extend from the terminus of the n. vestibularis to the lateral areas of the formatio reticularis of both sides; of these a part acts upon the motor trigeminus nucleus and farther up upon the oculomotorius nucleus, arriving finally in the ventrolateral nucleus of the thalamus; hence connection is made with the somaesthetic area. Special paths from the lateral and superior nuclei connect with the nucleus fastigii of the cerebellum, the nucleus dentatus and the cortex of the vermis.

b) The *nervus cochlearis* arises from the *ganglion spirale;* its central root perforates the posterior, lateral margin of the pons and ends in the *nucleus n. cochlearis ventralis* and the *nucleus n. cochlearis dorsalis [nucleus tuberculi acustici]* (see Figs. 781, 790, 791 and 796). From the latter proceed the inconstant striae medullares; from the ventral nucleus arises the corpus trapezoideum, the nerve fibres of which are supplemented by others from the upper olive and the trapezoid nucleus. The upward continuation of the trapezoid body is the *lateral lemniscus (lemniscus lateralis [acusticus]);* it carries fibres from the corpus trapezoideum of both sides, also fibres from the *nucleus lemnisci lateralis* and ends in the nucleus of the inferior colliculus of the same and of the opposite side, as well as in the middle gray matter of the superior colliculus (see also optic-acoustic reflex path p. 695). Another part, supplemented by paths from the inferior colliculi, goes to the corpus geniculatum mediale, or directly over into the higher conduction path, extending from this geniculate body to the cortex of the gyri temporales transversi *(auditory sphere)* (see Figs. 805—811).

9. 10. **N. glossopharyngeus** and **n. vagus** (see Fig. 805). Their motor fibres arise partly in the *nucleus dorsalis nn. glossopharyngei et vagi* (medial from the ala cinerea), partly in the *nucleus ventralis [nucleus ambiguus]*, which lies in the formatio reticularis dorsal from the dorsal accessory olive (see Figs. 780, 781 and 789). Their sensory fibres arise in the *ganglion superius* and *petrosum n. glossopharyngei,* and in the *ganglion jugulare* and *nodosum n. vagi* and pass upward in an oblique direction from the lateral margin of the medulla oblongata to the ala cinerea. Through bifurcation of their nerve fibres the *tractus solitarius* arises. Their primary terminal domain is the *nucleus alae cinereae,* the *nucleus tractus solitarii* and the *ganglion commissurale alae cinereae* (see Figs. 779—781, 788 and 789). Reflex fibres extend to the dorsal vago-glossopharyngeal and to the hypoglossal nucleus. The secondary paths lie in the lateral areas of the formatio reticularis of the same and of the opposite side, as well as in the crossed interolivary layer. Fibres from the pyramidal tract pass to the motor nuclei.

11. **N. accessorius.** Its upper bundles arise along with the motor portion of the vagus, the lower spinal bundles, on the other hand, from the dorsolateral group of anterior horn cells as far down as the 5th—7th cervical segment (see p. 686 and Fig. 805).

12. **N. hypoglossus** arises in the *nucleus n. hypoglossi* in the floor of the rhomboid fossa and in the central gray matter at the end of the central canal (see Figs. 780, 789 and 805). The nuclei receive voluntary innervation from the pars frontalis of the operculum (see Fig. 811) by way of the pyramidal tract through fibres running upward in the raphe which dominate both nuclei.

Connections of the cerebellum. (Held.)

The conduction paths of the cerebellum on each side ending or arising in its gray cortex and its subcortical ganglia lie chiefly in three great bundles, which are distinguished macroscopically as the *restiform body,* the *arm of the pons* and the *connecting arm.* Macroscopically inseparable from the restiform body is a fourth bundle called the *medial part of the corpus restiforme.*

1. The ***corpus restiforme*** (O. T. inferior cerebellar peduncle) unites the ***paths from the spinal cord and the medulla oblongata.*** These arise

a) from Clarke's column of the same side *(direct cerebellar tract)* (see p. 695). [A path parallel to the direct cerebellar tract is the *cerebellar path of the anterior funiculus (Gowers' tract)* (see also p. 695), which runs on the more ventral surface of the medulla oblongata, is covered later by the pons, then loops around the lateral lemniscus and the brachium conjunctivum, and, passing along the velum medullare anterius, ends in the vermis (see Figs. 778—784, 788—793 and 803)];

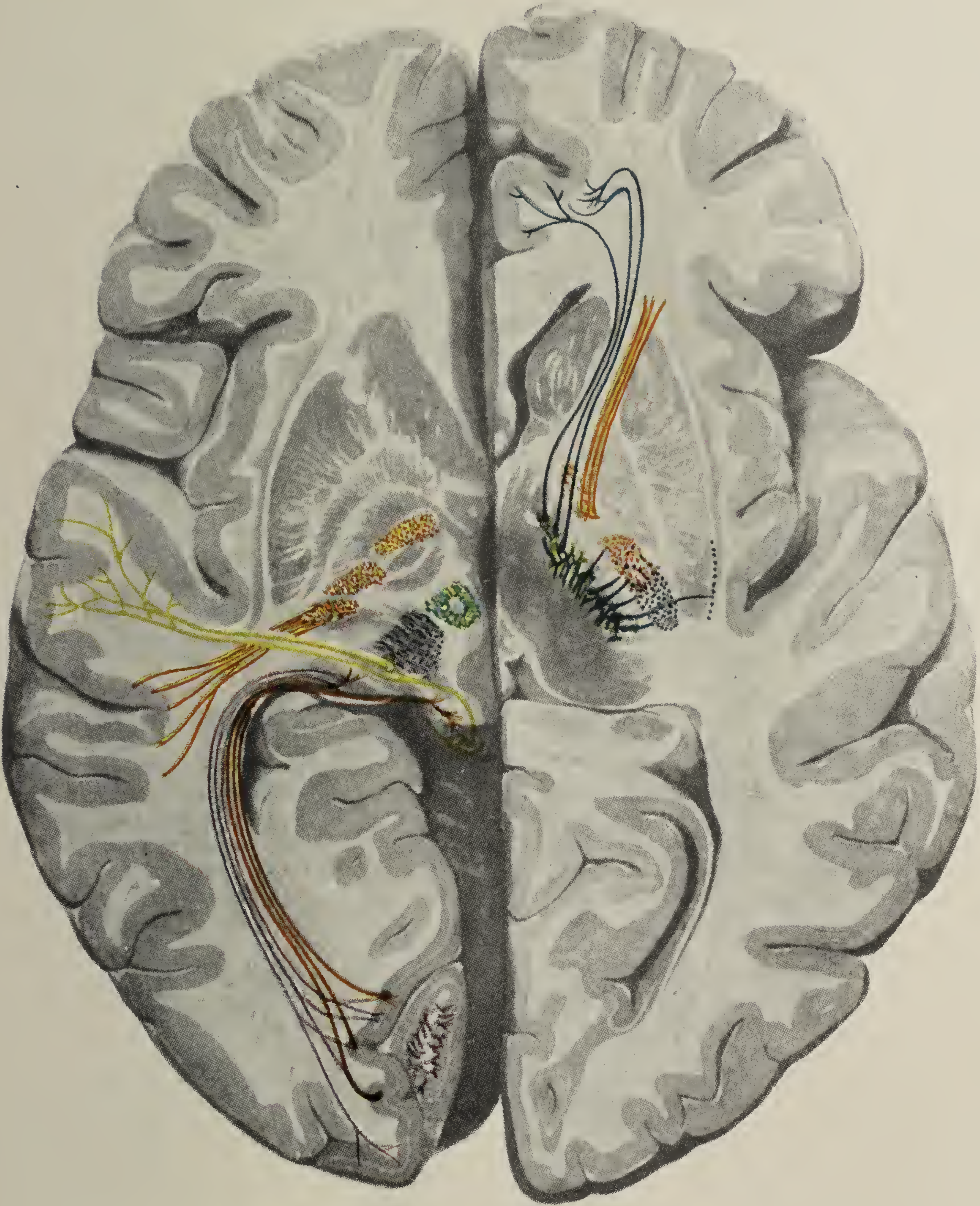
b) from the nuclei of the posterior funiculi of the same and of the opposite side (sensory decussation, *fibrae arcuatae internae* and *externae)* (see Figs. 779 and 788);

c) from the inferior olives of the same and of the opposite side *(fibrae cerebelloolivares)* (descending paths also run in this *olive-worm-path)* (see Figs. 780, 781, 789 and 790);

d) from the nucleus of the lateral funiculus.

The corpus restiforme ends in the nucleus dentatus, nucleus emboliformis and nucleus globosus (chiefly through collaterals), the nucleus of the roof and in the cortex of the vermis (see Figs. 791, 792, 796 and 806).

2. The ***medial part of the corpus restiforme*** (see Fig. 792) consists in large part of the *direct sensory cerebellar path,* which passes from the terminal nuclei of the nn. glossopharyngeus, vagus, vestibularis and trigeminus to the nucleus of the roof and the cortex of the vermis. There are also descending paths which go from here partly directly by way of the formatio reticularis into the anterolateral funiculus of the spinal cord, in large part, however, indirectly, ending in Deiters' nucleus, from which a bundle descends to the lateral funiculus.



808. Position of the pyramidal tract (red), **secondary optic radiation** (orange), **frontal pontile path** (dark-brown), **temporal pontile path** (light-brown), **auditory conduction path** (yellow), **primary optic radiation** (violet), **medial lemniscus** (blue), **brachium conjunctivum** (green), **cortical path from the ventrolateral nucleus of the thalamus** (blue), introduced into Fig. 801. (Held.)

3. The ***arms of the pons,*** *brachia pontis,* (O. T. middle cerebellar peduncles) arise in the cortex of the cerebellar hemispheres and end in the nuclei pontis of the same and of the opposite side; paths in the opposite direction also exist. Farther continuations are a) the *median descending pontile path* (see Figs. 782—785), which penetrates the tegmentum of the pons and hence in part descends to the spinal cord, in part ascends toward the corpora quadrigemina, as well as b) the *corticopetal fibres of the cerebropontile paths* (chiefly of the temporal).

4. The ***connecting arms, brachia conjunctiva,*** proceed chiefly from the nucleus dentatus (supplemented by paths from the nucleus fastigii and the cortex of the vermis), decussate in the raphe of the tegmentum, become connected by collaterals with the red nucleus, which, through its bundle to the lateral funiculus, innervates the opposite half of the spinal cord, and end in large part finally, together with the medial lemniscus, in the ventrolateral nucleus of the thalamus, whence the cortical path passes to the somaesthetic area (see Figs. 797, 806 and 808).

Connections of the cerebrum. (Held.) The white substance of the cerebrum contains 1. proper, endogenous conduction paths, the *association fibres,* which unite spatially separated and functionally non-equivalent gyri of the cortex with one another, 2. those which bring the cerebral cortex (or parts homologous with it: nucleus caudatus, putamen) into relation with the thalamus, the so-called *corona radiata of the thalamus (radiation of the thalamus),* 3. paths which connect the cerebral cortex with lower regions of the central nervous system (brain-stem, medulla oblongata, spinal cord) and which are contained in the stem-bundles. The two latter form the system of *projection fibres* and include the sensory conduction paths as well as the motor paths which transfer the voluntary impulses of the cerebral cortex to the lower nuclei of origin of the individual muscle nerves.

I. The ***association fibres*** are intercortical conduction paths, and as such unite either different gyri of the same hemisphere or of the two hemispheres. The latter are contained in the corpus callosum, the anterior commissure and the commissura hippocampi.

II. While the association fibres run more superficially beneath the cortex and follow its surface, the ***radiation of the thalamus*** presents a fan-like arrangement toward the depth. It is arranged in the gross form of the so-called *peduncles of the thalamus,* the anterior, superior, posterior and inferior peduncles converging from the frontal, parietal, occipital and temporal lobes respectively to the thalamus, and there helping to form, on its outer surface and on that of the nucleus caudatus, the capsula interna. Ascending and descending conduction paths are to be distinguished in this radiation *(Stabkranz).*

1. The *ascending conduction paths* of the radiation carry the different sensory paths to the sense centres of the cerebral cortex (see Figs. 806—812):

a) From the ventrolateral nucleus of the thalamus to the cortex of the *somaesthetic area* (see Figs. 811 and 812); these are the continuations of the medial lemniscus, of the lateral areas of the formatio reticularis and of the brachia conjunctiva (see Fig. 806). (A small part of the first mentioned goes directly through the thalamus without interruption.) They lie in larger part in the posterior third of the capsula interna (see Fig. 808), in smaller part also, after perforating or encircling the nucleus lentiformis from below, in the capsula externa (see Fig. 806).

b) Behind this the *auditory conduction path* emerges from the internal capsule; it runs transversely a little behind the free posterior margin of the nucleus lentiformis and passes directly lateralward to the cortex of the gyrus temporalis superior and gyri temporales transversi (see Fig. 809).

c) The *visual conduction path (primary optic radiation* of Flechsig), emerging lateralward and below the pulvinar and lateral geniculate body, runs straight occipitalward to the cortex about the fissura calcarina *(visual sphere)* (see also p. 698 and Fig. 810).

2. *Descending conduction paths.* They arise in general from the pyramidal cells of the cerebral cortex and end in part in the subcortical ganglia of the cerebrum or in the mid-brain. Here belong, among others:

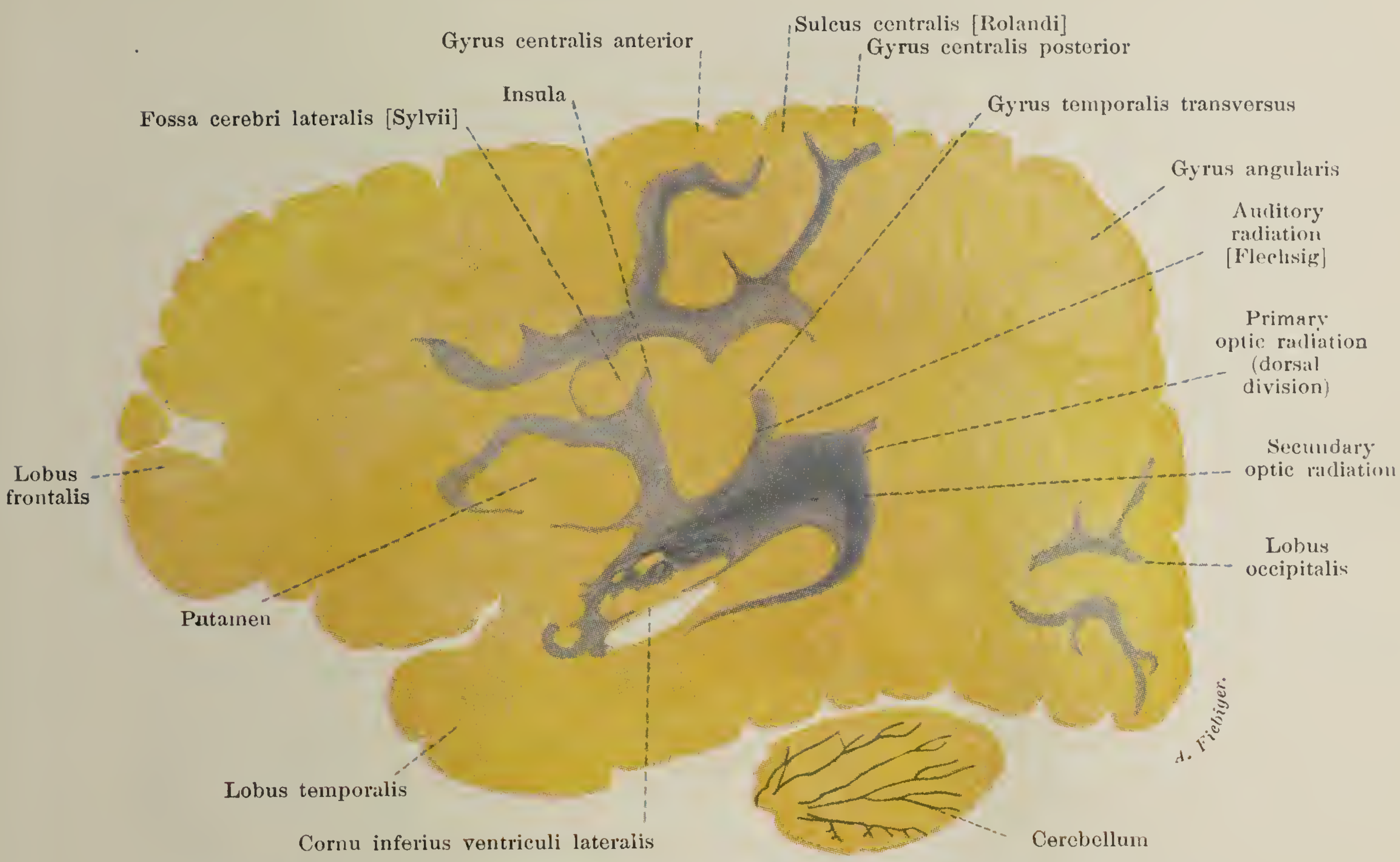
A) The part of the fornix which as the fimbria proceeds from the cortex of the hippocampus, and as the columna fornicis ends in the corpus mamillare of the same and of the opposite sides, whence the path is continued, partly as the *fasciculus thalamomamillaris [Vicq d'Azyri]* to the anterior nucleus of the thalamus (see Figs. 773 and 798), partly as the *fasciculus tegmentomamillaris* to the tegmentum of the base of the cerebral peduncle. Here belongs also the *secondary visual conduction path (secondary optic radiation)* (see also p. 698 and Figs. 806, 808 and 810), which acts upon the superior colliculus.

B) Of the descending conduction paths of the cortex a large part passes through the capsula interna directly into the base of the cerebral peduncle and ends at varying depths (see Figs. 787, 807 and 808):

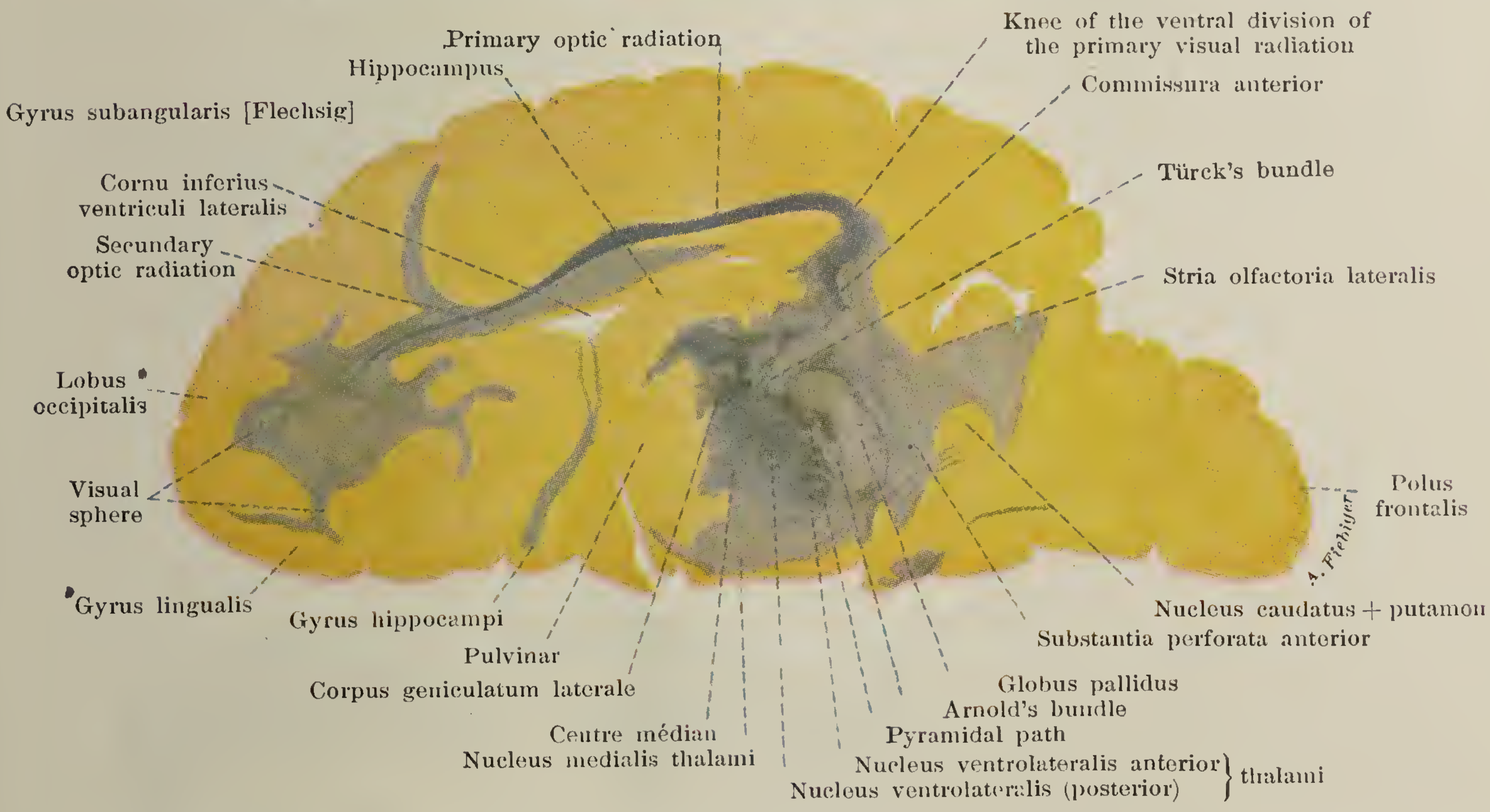
a) *Frontal [cerebro]pontile path (Arnold's bundle).* It arises from the frontal layers of the somaesthetic area and ends in the gray matter of the pons. On its way it lies in the anterior (frontal) areas of the internal capsule, and farther down in the medial part of the base of the cerebral peduncle. Toward the pyramidal tract lie special motor conduction paths for the nuclei of the motor cerebral nerves *(corticobulbar path).*

b) *Temporal [cerebro]pontile path (Türck's bundle).* It unites the temporal lobe with the pons. It lies in the most posterior part of the capsule, which it, together with the auditory conduction path, bounds; farther down, in the base of the cerebral peduncle, it lies lateral from the pyramidal tract.

c) *Pyramidal tract.* It arises in the large pyramidal cells of the anterior central gyrus. Besides the motor fibres for the nuclei of the cerebral nerves, it carries also chiefly fibres for the motor anterior horns of the spinal cord. In the internal capsule the paths for the motor nerves of the upper extremity lie more frontalward and are separate from those for the lower extremity.


Sulcus centralis [Rolandi]
Gyrus centralis anterior
Gyrus centralis posterior
Insula
Fossa cerebri lateralis [Sylvii]
Gyrus temporalis transversus
Gyrus angularis
Auditory radiation [Flechsig]
Primary optic radiation (dorsal division)
Secundary optic radiation
Lobus frontalis
Lobus occipitalis
Putamen
A. Fiebiger.
Lobus temporalis
Cornu inferius ventriculi lateralis
Cerebellum

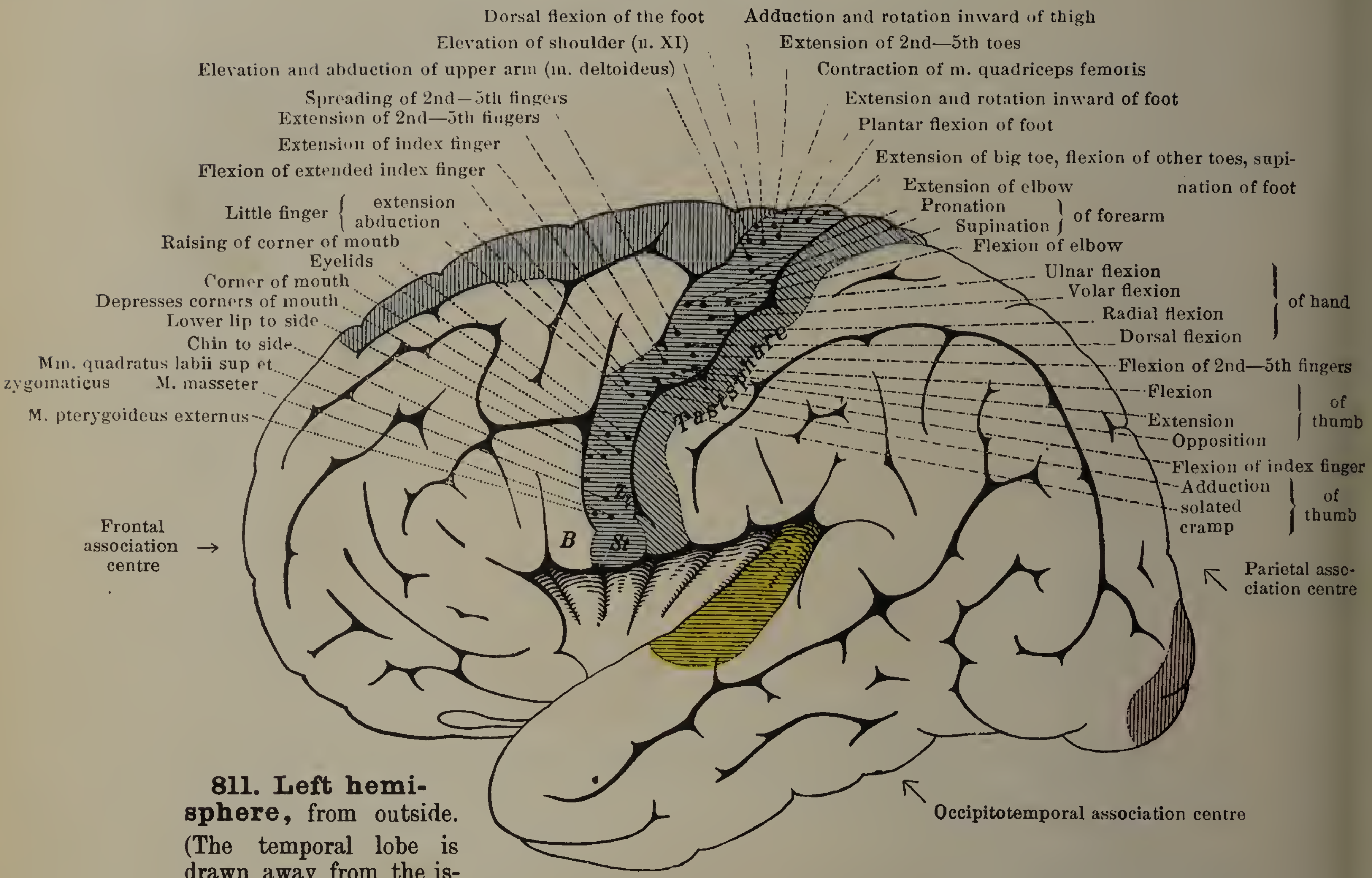
809. **Sagittal section through the brain of a 7 weeks old infant.**


Primary optic radiation
Hippocampus
Gyrus subangularis [Flechsig]
Knee of the ventral division of the primary visual radiation
Commissura anterior
Türck's bundle
Cornu inferius ventriculi lateralis
Secundary optic radiation
Stria olfactoria lateralis
Lobus occipitalis
Visual sphere
Polus frontalis
A. Fiebiger.
Gyrus lingualis
Gyrus hippocampi
Pulvinar
Corpus geniculatum laterale
Nucleus caudatus + putamen
Substantia perforata anterior
Globus pallidus
Arnold's bundle
Pyramidal path
Centre médian
Nucleus medialis thalami
Nucleus ventrolateralis anterior
Nucleus ventrolateralis (posterior)
thalami

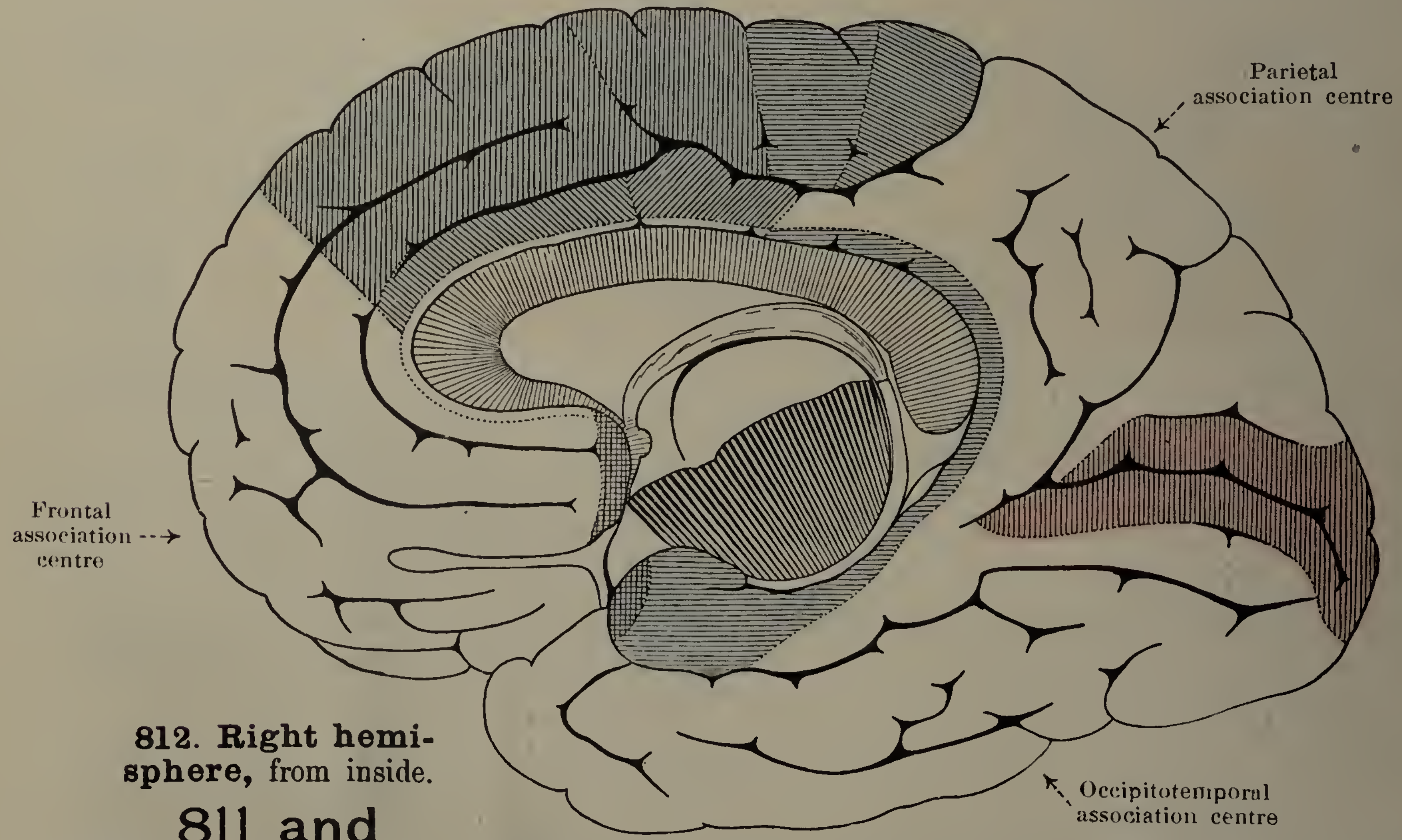
810. **Section through the cerebral hemisphere of a 16 days old infant.**
The section is made obliquely and deviates from the horizontal plane so that, the border neighboring the median plane (the lower border of the figure) lies higher than the convex.

809 and 810. Section through the brain (after P. Flechsig) to demonstrate the fact that the nerve fibres of various central paths are ensheathed by medulla at different times. Natural size.

(The medullated nerve fibres are blue.)


Dorsal flexion of the foot
Elevation of shoulder (n. XI)
Elevation and abduction of upper arm (m. deltoideus)
Spreading of 2nd—5th fingers
Extension of 2nd—5th fingers
Extension of index finger
Flexion of extended index finger
Little finger { extension abduction
Raising of corner of mouth
Eyelids
Corner of mouth
Depresses corners of mouth
Lower lip to side
Chin to side
Mm. quadratus labii sup et zygomaticus
M. masseter
M. pterygoideus externus
Frontal association centre
Adduction and rotation inward of thigh
Extension of 2nd—5th toes
Contraction of m. quadriceps femoris
Extension and rotation inward of foot
Plantar flexion of foot
Extension of big toe, flexion of other toes, supination of foot
Extension of elbow
Pronation } of forearm
Supination
Flexion of elbow
Ulnar flexion
Volar flexion
Radial flexion } of hand
Dorsal flexion
Flexion of 2nd—5th fingers
Flexion
Extension } of thumb
Opposition
Flexion of index finger
Adduction
solated } of thumb
cramp
Parietal association centre
Tastsphäre
Z?
B
St
Occipitotemporal association centre

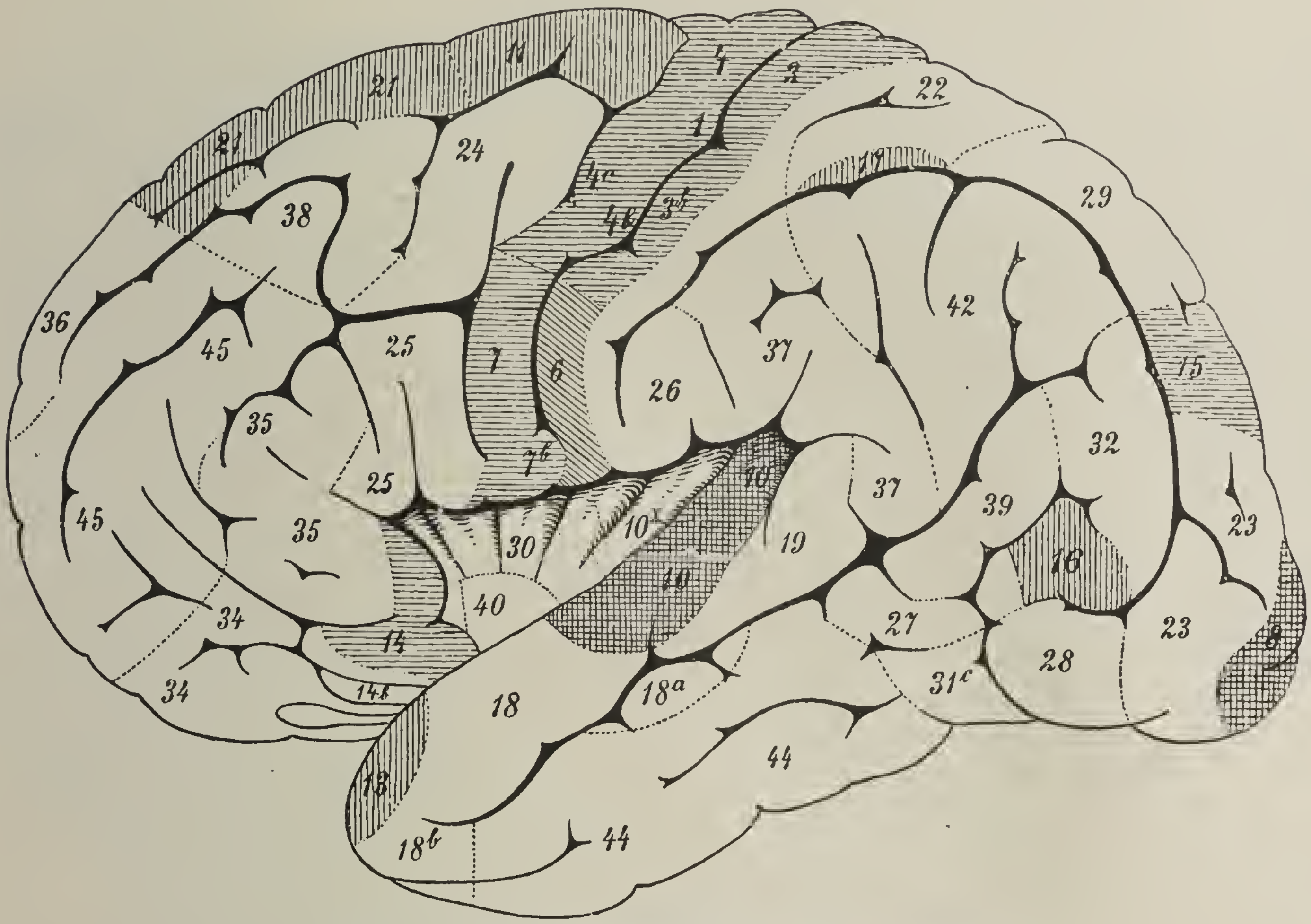
811. Left hemisphere, from outside. (The temporal lobe is drawn away from the island to expose the transverse gyri [Flechsig].) The dots indicate the points of electric stimulation after F. Krause. Z(?) = Tongue; St = Vocal cords; B = Broca's convolution.


Parietal association centre
Frontal association centre
Occipitotemporal association centre

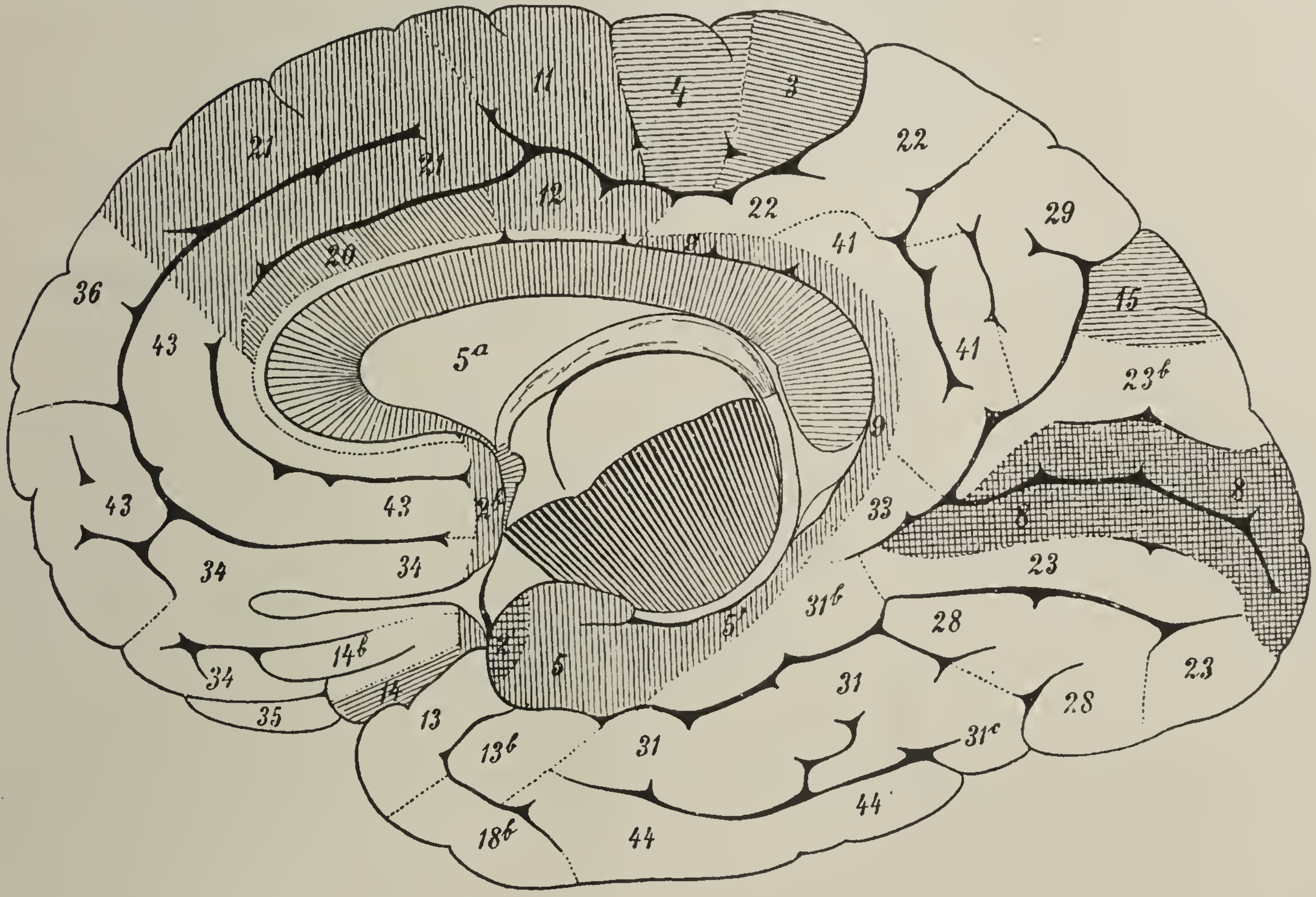
812. Right hemisphere, from inside.

811 and 812. Cortical areas of the cerebral hemispheres

(after P. Flechsig). (For names of gyri, sulci etc. see Figs. 759—762.) Sphere of general sensibility and mobility blue; olfactory and gustatory (?) spheres dotted blue, visual sphere violet, auditory sphere yellow, association centres white.



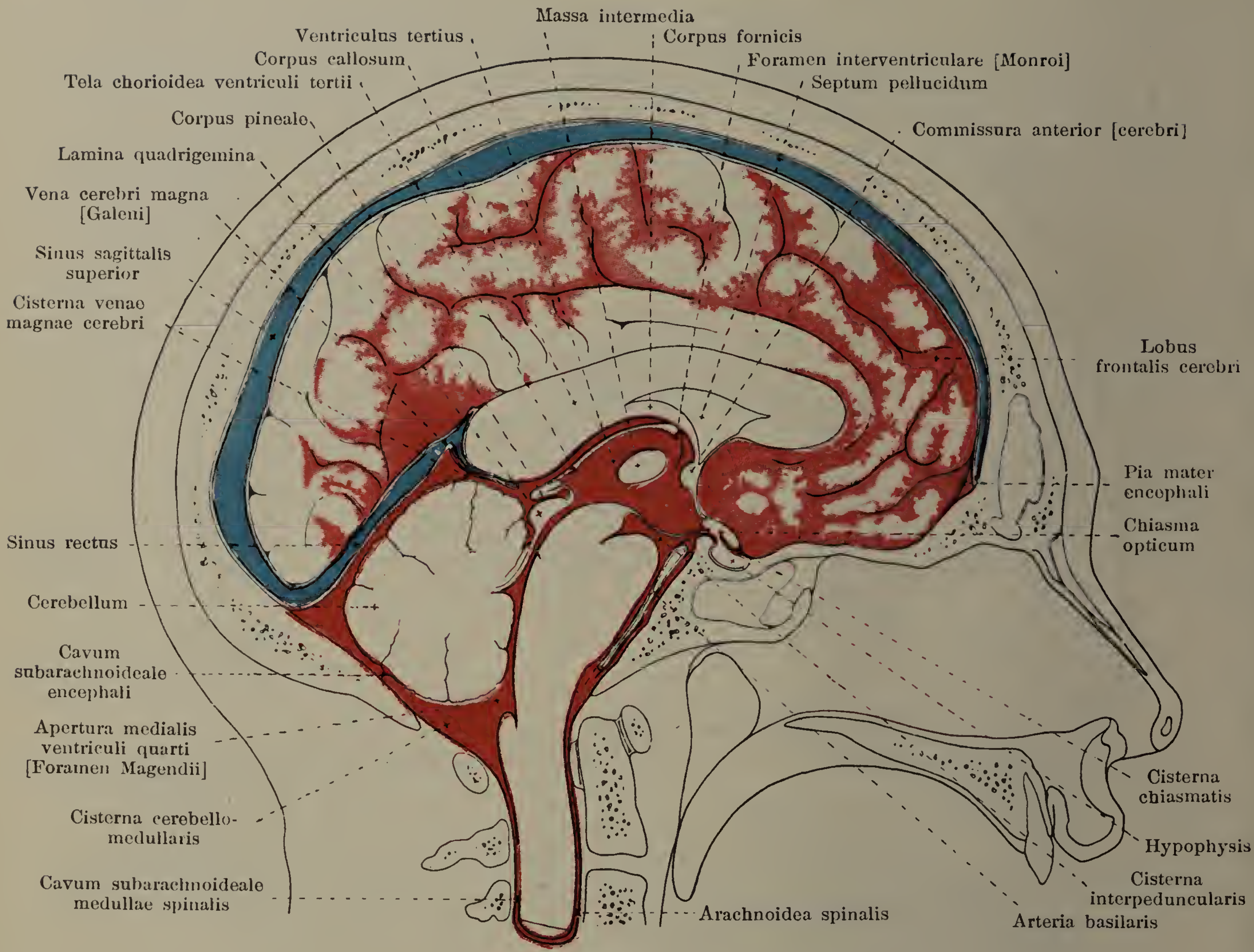
813. Left hemisphere, from without.
(The temporal lobe somewhat drawn away from the island to expose its transverse gyri.)



814. Right hemisphere, from within.

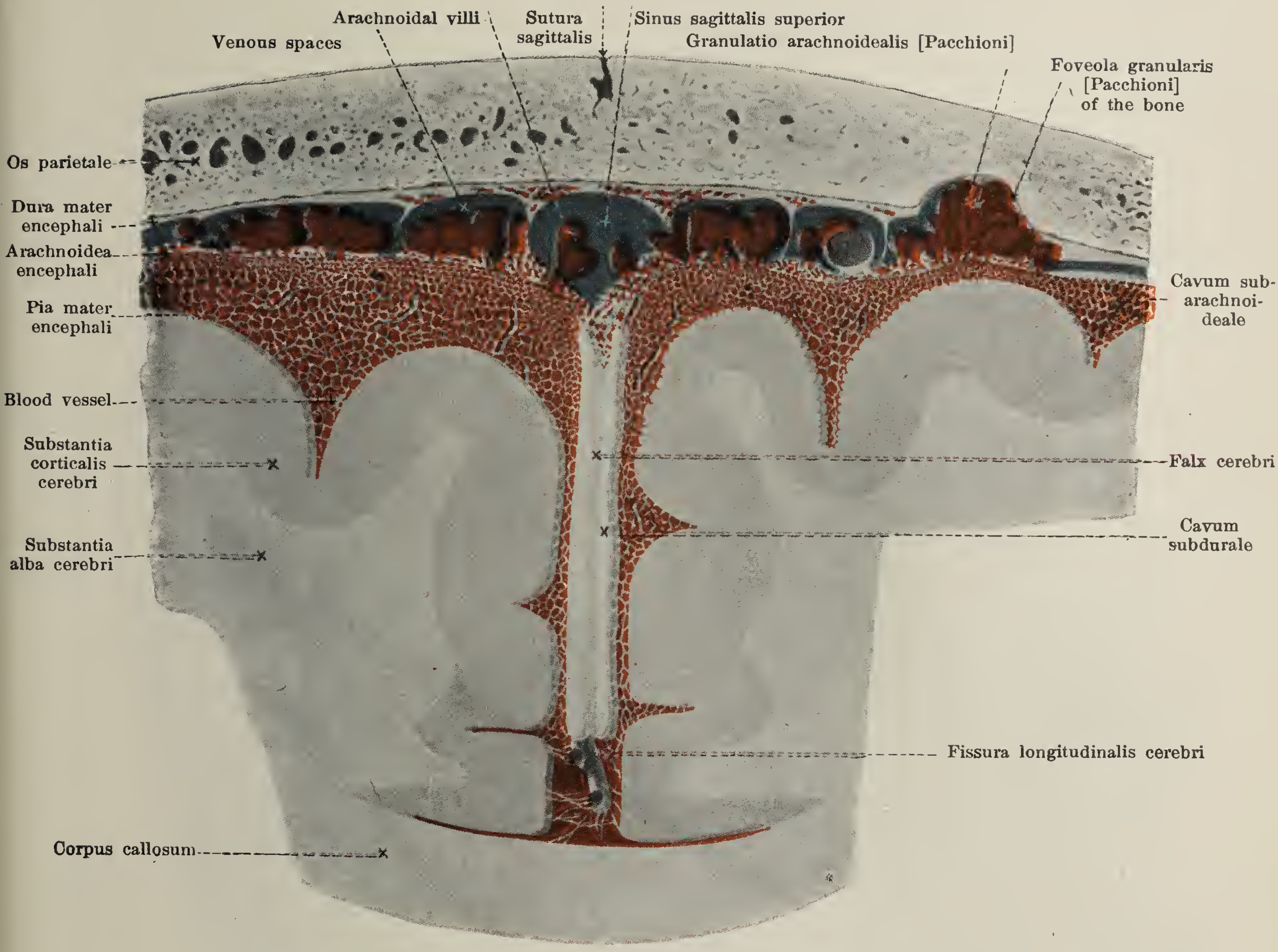
813 and 814. Medullation of the cortical areas of the cerebral hemispheres (after P. Flechsig).

(For names of convolutions, sulci etc. see Figs. 759—762.) The figures indicate the order in which the fibres in the various areas are medullated. The shaded areas are medullated at birth.


Massa intermedia
Ventriculus tertius
Corpus fornicis
Corpus callosum
Foramen interventriculare [Monroi]
Tela chorioidea ventriculi tertii
Septum pellucidum
Corpus pineale
Commissura anterior [cerebri]
Lamina quadrigemina
Vena cerebri magna [Galeni]
Sinus sagittalis superior
Cisterna venae magnae cerebri
Lobus frontalis cerebri
Pia mater encephali
Chiasma opticum
Sinus rectus
Cerebellum
Cavum subarachnoideale encephali
Apertura medialis ventriculi quarti [Foramen Magendii]
Cisterna chiasmatis
Cisterna cerebello-medullaris
Hypophysis
Cisterna interpeduncularis
Cavum subarachnoideale medullae spinalis
Arachnoidea spinalis
Arteria basilaris

815. The subarachnoideal spaces in a median section of the head, left half, viewed from the right.
(Partly after illustrations by W. Braune, and by Key and Retzius.)
(The subarachnoidal spaces and the ventricles of the brain connected with them have been injected with a red-colored mass. The falx cerebri has been removed.)

The ***arachnoidea encephali (cobweb membrane)*** (see also Fig. 816) is a very delicate non-vascular membrane loosely attached to the pia mater encephali (see p. 674) by numerous strands and membranes which transform the *cavum subarachnoideale,* situated between the pia mater and the arachnoidea and filled with serous *liquor cerebrospinalis,* into a system of smaller and larger communicating spaces. On the convex surface of the cerebrum the arachnoidea is attached to the summits of the gyri by shorter strands; it does not penetrate into the sulci with the exception of the fissura longitudinalis cerebri, but is stretched out over these from one gyrus to the next. Hence larger spaces arise over each sulcus. Still larger cavities, *cisternae subarachnoideales*, are to be found, especially at the base of the brain. The largest of these, *cisterna cerebellomedullaris,* arises through the fact that the arachnoidea encephali as a continuation of the arachnoidea spinalis extends from the dorsal surface of the medulla oblongata over the fissura transversa cerebelli (see p. 655) directly to the lower surface of the cerebellum. The arachnoidea does not even penetrate into the fissura transversa cerebri (see p. 657); hence in the neighborhood of the vena cerebri magna [Galeni] arises the *cisterna venae cerebri magnae*, which extends far forward between the layers of the tela chorioidea ventriculi tertii (see p. 674). From the anterior surface of the medulla oblongata the arachnoidea stretches in front of the pons and the brachia pontis lateralward as far as the surface of the cerebellum, then, passing out from the upper margin of the pons bridges over the corpora mamillaria and their neighborhood (see Fig. 758) to reach the temporal lobes lateralward and the frontal lobes forward, in front of the chiasma opticum.

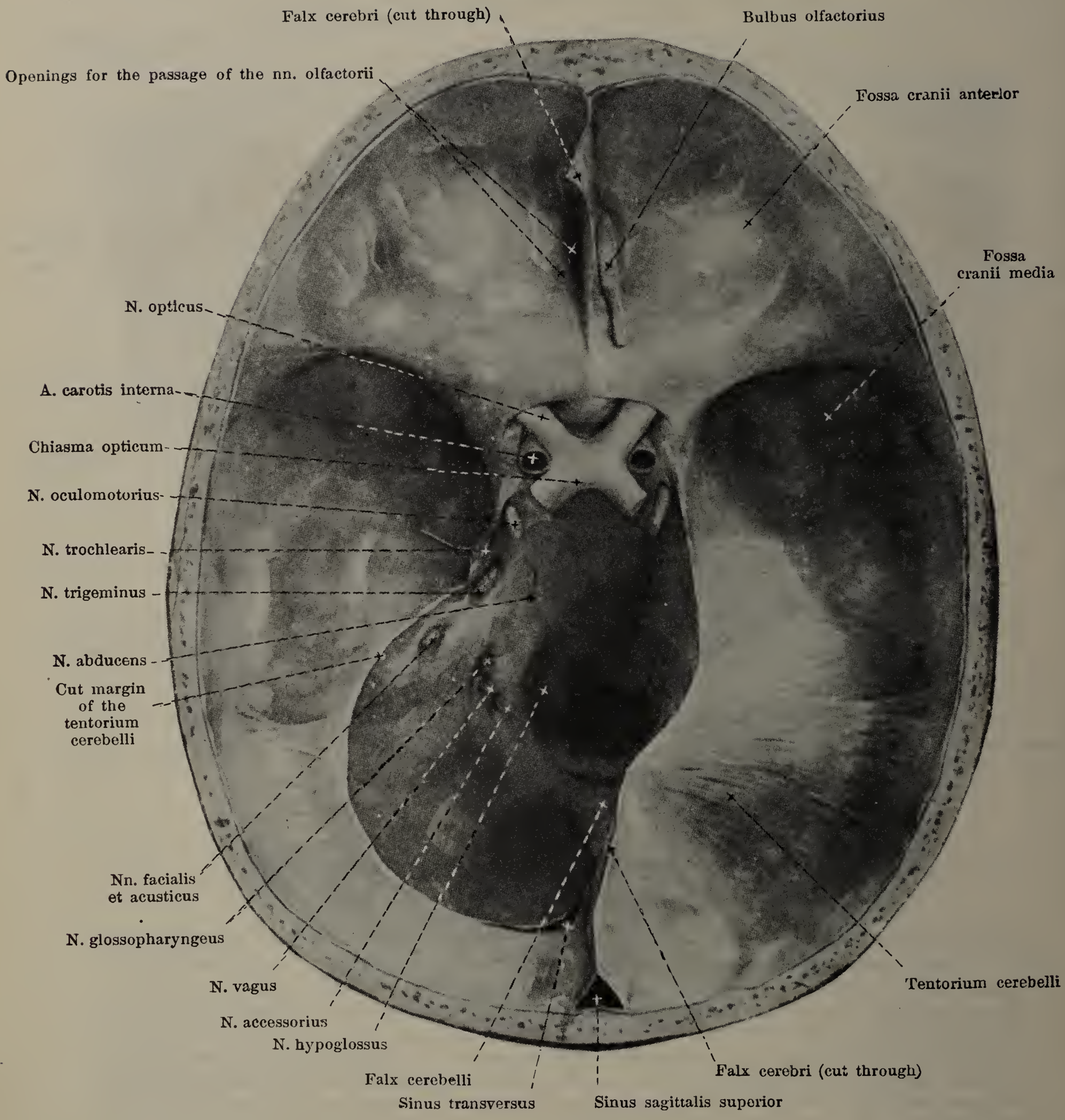


816. Frontal section through the skull, meninges and brain (after Key and Retzius).

(The subarachnoidal spaces have been injected with a red-colored mass.) Magnification: 5:2.

Arachnoidea encephali (continued) (see also Fig. 815). There thus arises a large subarachnoidal space, through which pass the a. basilaris, the tractus optici and the beginnings of the cerebral nerves; the portion situated behind the infundibulum is called the *cisterna interpeduncularis*, that below and in front of the chiasma opticum the *cisterna chiasmatis* (see Fig. 815). Adjacent to these lateralward on each side is the *cisterna fossae cerebri lateralis [Sylvii]* (not illustrated), which owes its origin to the fact that the arachnoidea does not penetrate into the depth of the fissura cerebri lateralis, but stretches out directly from the surface of the temporal lobe to the frontal lobe.

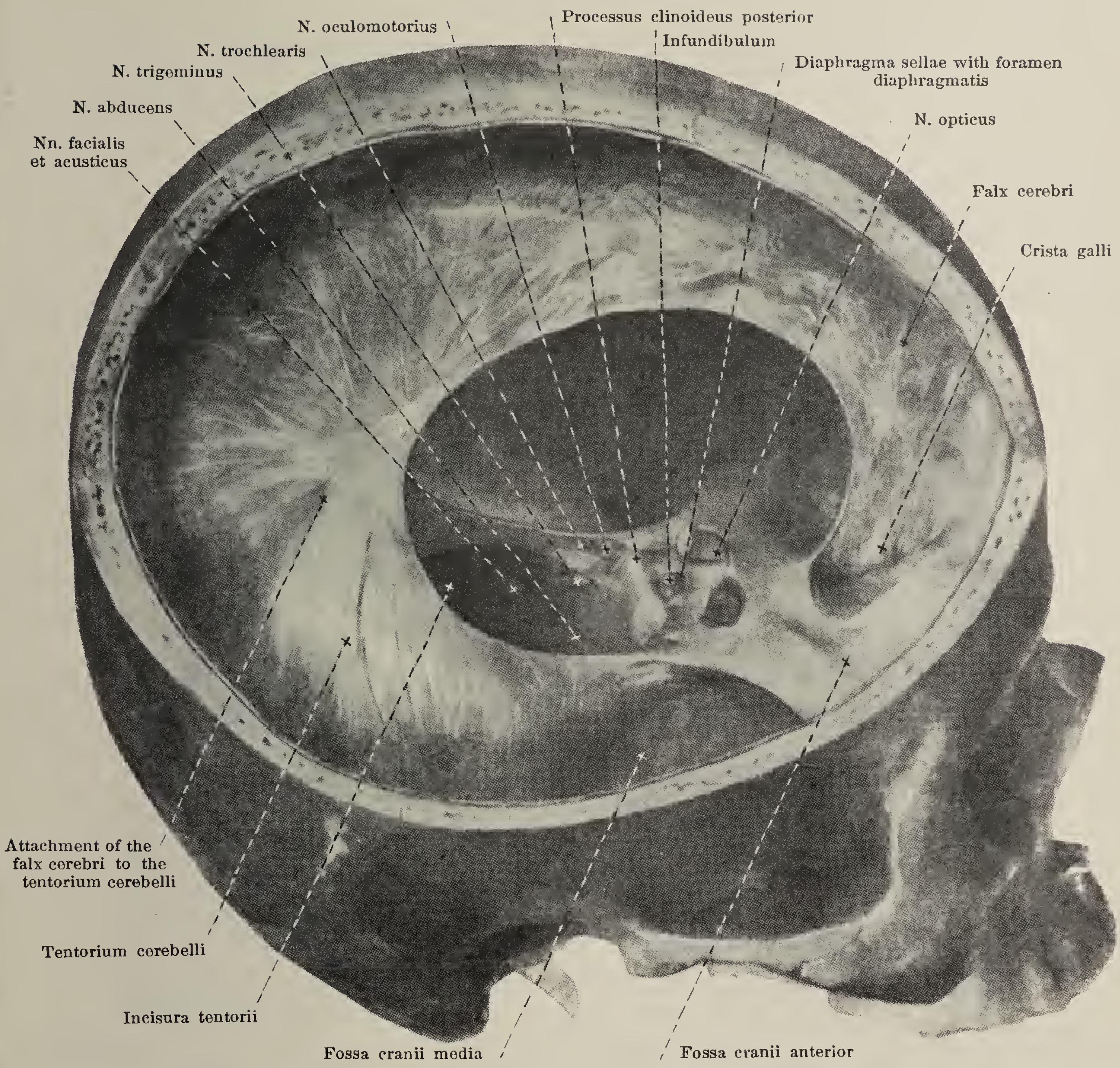
Projecting from the outer surface of the arachnoidea encephali are numerous grayish-red villus-like appendages *(arachnoidal villi)*, varying in size from that of a millet-seed to that of a grain of wheat, which are united as a rule in groups as the *granulationes arachnoideales [Pacchioni]*. They are remarkably variable, are absent in early childhood, usually appear in the tenth year of life, are regularly present in the adult, and especially abundant in old age; they are less developed in woman than in man. They are attached to the arachnoidea by delicate pedicles in the form of flask-like outgrowths, and contain within them a network of connective tissue strands as well as of subarachnoidal spaces. They penetrate the dura mater and project into the sinuses or into venous spaces with which these communicate. They can become so large that the bone opposite them is absorbed and becomes deepened to form a *foveola granularis [Pacchioni]*. They are most numerous and largest in front at the sinus sagittalis superior and in its neighborhood, especially in the middle portion; they are smaller and less numerous at the pole of the temporal lobe, as well as, from the cerebellar surface, at the sinus rectus, sinus transversus and sinus petrosus superior.



817. Dura mater, viewed from above.

(The falx cerebri has been almost completely removed, the tentorium cerebelli on the left side only.)

The ***dura mater encephali (hard membrane of the brain)*** (see also Figs. 818 and 819), a white, tough, connective tissue membrane, glistening like tendon, lines the cavity of the skull like a periosteum. In children it is everywhere firmly attached to the bone, but in the adult is intimately attached only in the region of the base of the skull and at the cranial sutures, being elsewhere united with it only loosely by means of numerous connective tissue threads; in the latter places a capillary lymph space, *cavum epidurale,* exists between it and the bone. The inner surface of the dura mater is smooth and is separated from the outer, likewise smooth surface of the arachnoidea encephali, by a capillary slit, *cavum subdurale,* which is lined on all sides by endothelium and contains only a very small amount of fluid (see Fig. 816).

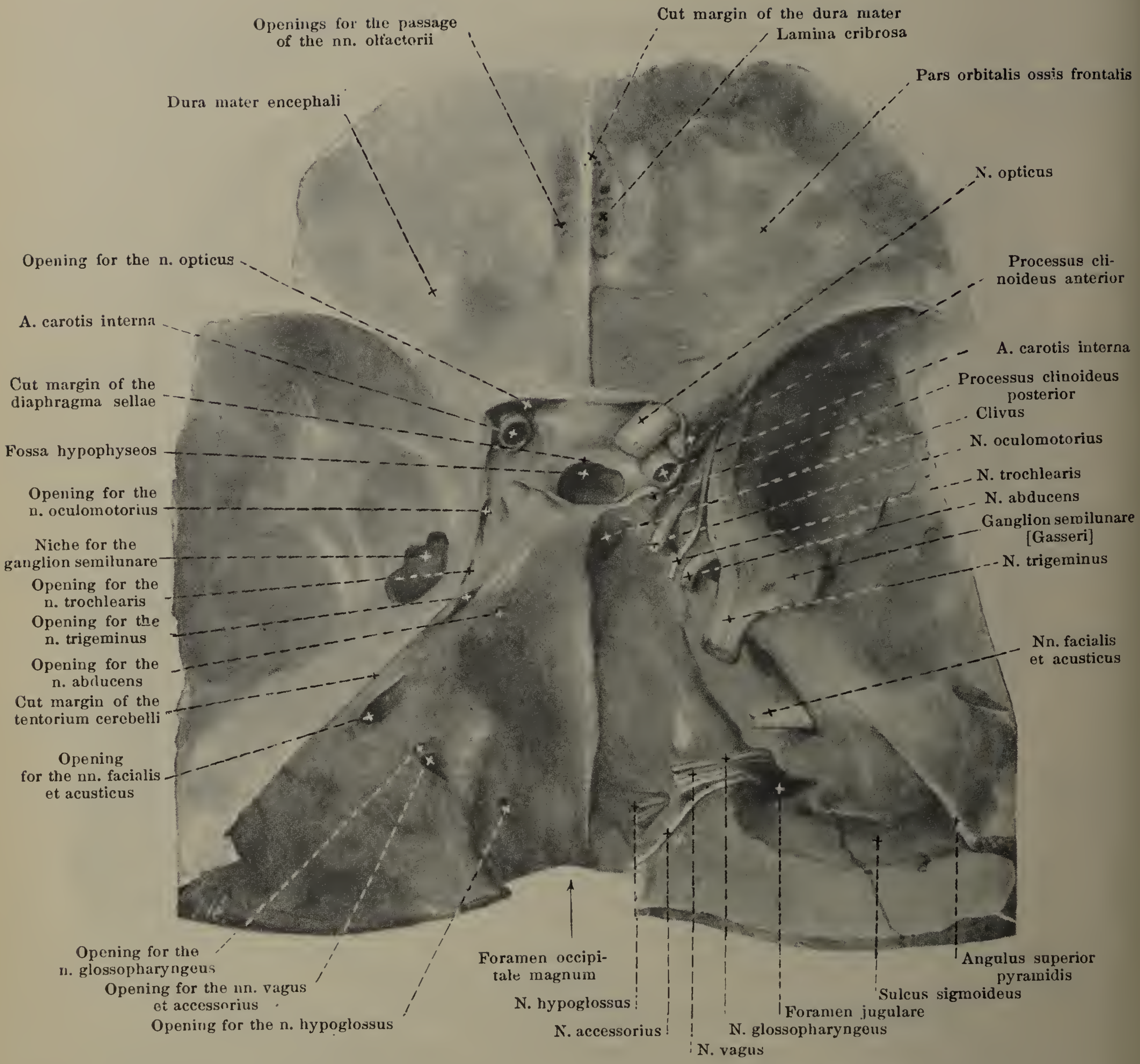


818. Dura mater, viewed from the right and above.

(A sector of the skull has been removed on the right side by a horizontal and a sagittal saw-cut.)

Dura mater encephali (continued) (see also Figs. 817 and 819). The dura mater completely lines the depth of the fossa hypophyseos, spreads out above the same between the tuberculum sellae and the upper margin of the dorsum sellae as *diaphragma sellae,* and there presents only a small opening, *foramen diaphragmatis [sellae],* for the passage of the infundibulum. It then runs lateralward on each side and stretches out from the processus clinoideus anterior and from the upper part of the processus clinoideus posterior to the angulus superior pyramidis (lateral from the impressio trigemini); thence it passes, behind, downward to the clivus and to the facies posterior pyramidis, laterally and in front, however, obliquely downward to the middle cranial fossa (lateral from the foramen rotundum and foramen ovale), and thus helps to enclose a large space (see Figs. 533 and 819), in which are situated the a. carotis interna, the sinus cavernosus, the n. oculomotorius, n. trochlearis, n. trigeminus along with its ganglion semilunare and its branches, as well as the n. abducens. The dura mater possesses three tough processes:

1. The *tentorium cerebelli (cerebellar tent)* (see also Figs. 535 and 817) goes off on each side in transversal direction from the angulus superior pyramidis and from the horizontal portion of the sulcus transversus, is sickle-shaped and in the middle elevated like the ridge of a roof; by its anterior, deeply notched margin it bounds the *incisura tentorii.* The occipital lobes of the cerebrum rest upon its upper surface.


Openings for the passage of the nn. olfactorii
Cut margin of the dura mater
Lamina cribrosa
Pars orbitalis ossis frontalis
Dura mater encephali
N. opticus
Opening for the n. opticus
Processus clinoideus anterior
A. carotis interna
A. carotis interna
Cut margin of the diaphragma sellae
Processus clinoideus posterior
Clivus
Fossa hypophyseos
N. oculomotorius
Opening for the n. oculomotorius
N. trochlearis
N. abducens
Ganglion semilunare [Gasseri]
Niche for the ganglion semilunare
N. trigeminus
Opening for the n. trochlearis
Opening for the n. trigeminus
Nn. facialis et acusticus
Opening for the n. abducens
Cut margin of the tentorium cerebelli
Opening for the nn. facialis et acusticus
Opening for the n. glossopharyngeus
Opening for the nn. vagus et accessorius
Opening for the n. hypoglossus
Foramen occipitale magnum
N. hypoglossus
N. accessorius
N. vagus
N. glossopharyngeus
Foramen jugulare
Sulcus sigmoideus
Angulus superior pyramidis

819. Passage of nerves through the dura mater and the skull.

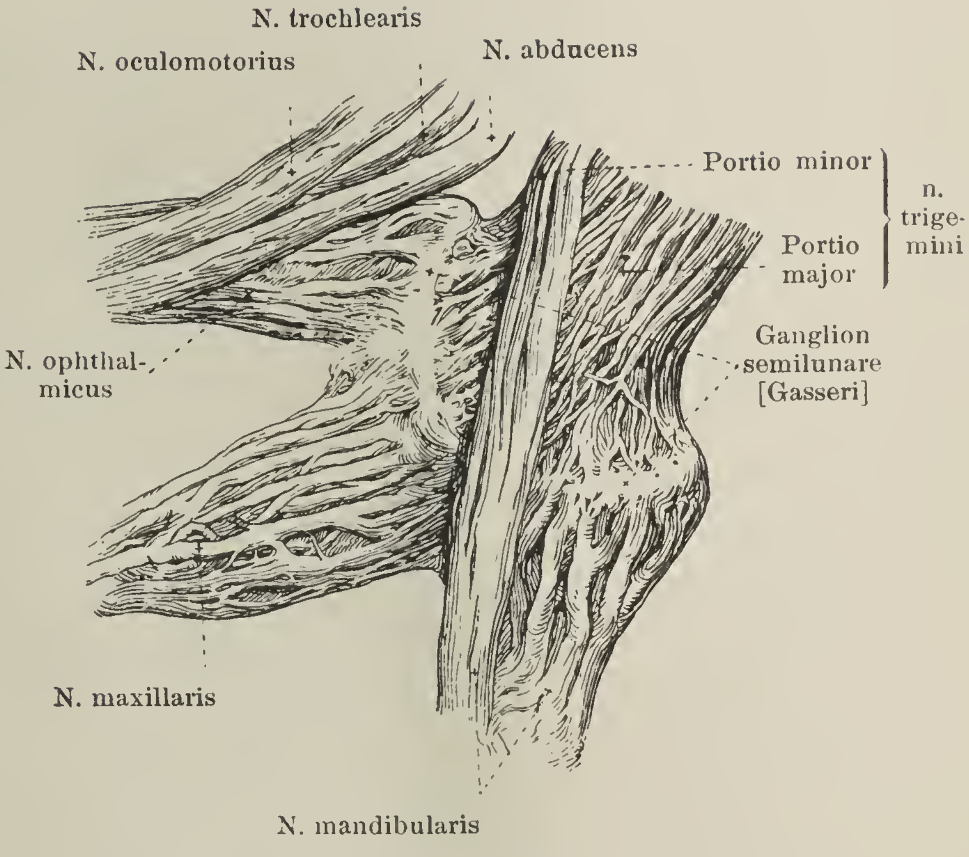
(On the right side the dura mater has been completely removed, on the left the tentorium cerebelli has been cut away at the temporal bone and the niche for the ganglion semilunare opened.)

Dura mater encephali (continued). 2. The *falx cerebri (cerebral sickle)* (see Figs. 535, 817 and 818), a septum increasing in height from before backward, penetrates from above in the median plane between the two cerebral hemispheres. It is attached at the crista galli, at the crista frontalis and at the sulcus sagittalis as far as the protuberantia occipitalis interna to the bone, fuses behind with the ridge-like edge of the tentorium cerebelli, and possesses below a concave margin which does not reach down as far as the corpus callosum of the brain (see Fig. 816). 3. The *falx cerebelli (cerebellar sickle)* (see Fig. 817) arises behind on the bony ridge which passes from the protuberantia occipitalis interna to the foramen occipitale magnum, is shoved in from behind as a low plate into the incisura cerebelli posterior, and ends in front with a concave margin; above it is united with the under surface of the tentorium cerebelli and below it runs out into two diverging low folds, which grasp the foramen occipitale magnum from behind.

820. Right ganglion semilunare [Gasseri],

viewed from the medial side.

Magnification: 2:1.



Twelve pairs of **nervi cerebrales, cerebral nerves,** go off from the brain. Of these, three (nn. olfactorii, optici, acustici) are pure sensory nerves, six (nn. oculomotorii, trochleares, abducentes, faciales, accessorii, hypoglossi) pure motor, three (nn. trigemini, glossopharyngei, vagi) mixed in nature. The nn. intermedii (see p. 724) are also of a mixed nature.

I. **Nervi olfactorii,** *olfactory nerves* (see Figs. 825 and 826), are sensory nerves, of which approximately twenty non-medullated threads of different size on each side leave the inferior surface of the bulbus olfactorius and arrive in the nasal cavity through the openings of the lamina cribrosa of the ethmoid bone. As they go they become ensheathed with processes of the meninges and of the subrarachnoidal spaces, divide into a lateral row which passes to the regio olfactoria of the lateral wall of the nose, and a medial row which goes to that of the nasa septum; they generally do not anastomose with one another. Their domain of distribution extends lateralward over a large part of the upper concha, and medianward it is of similar extent (see Fig. 984).

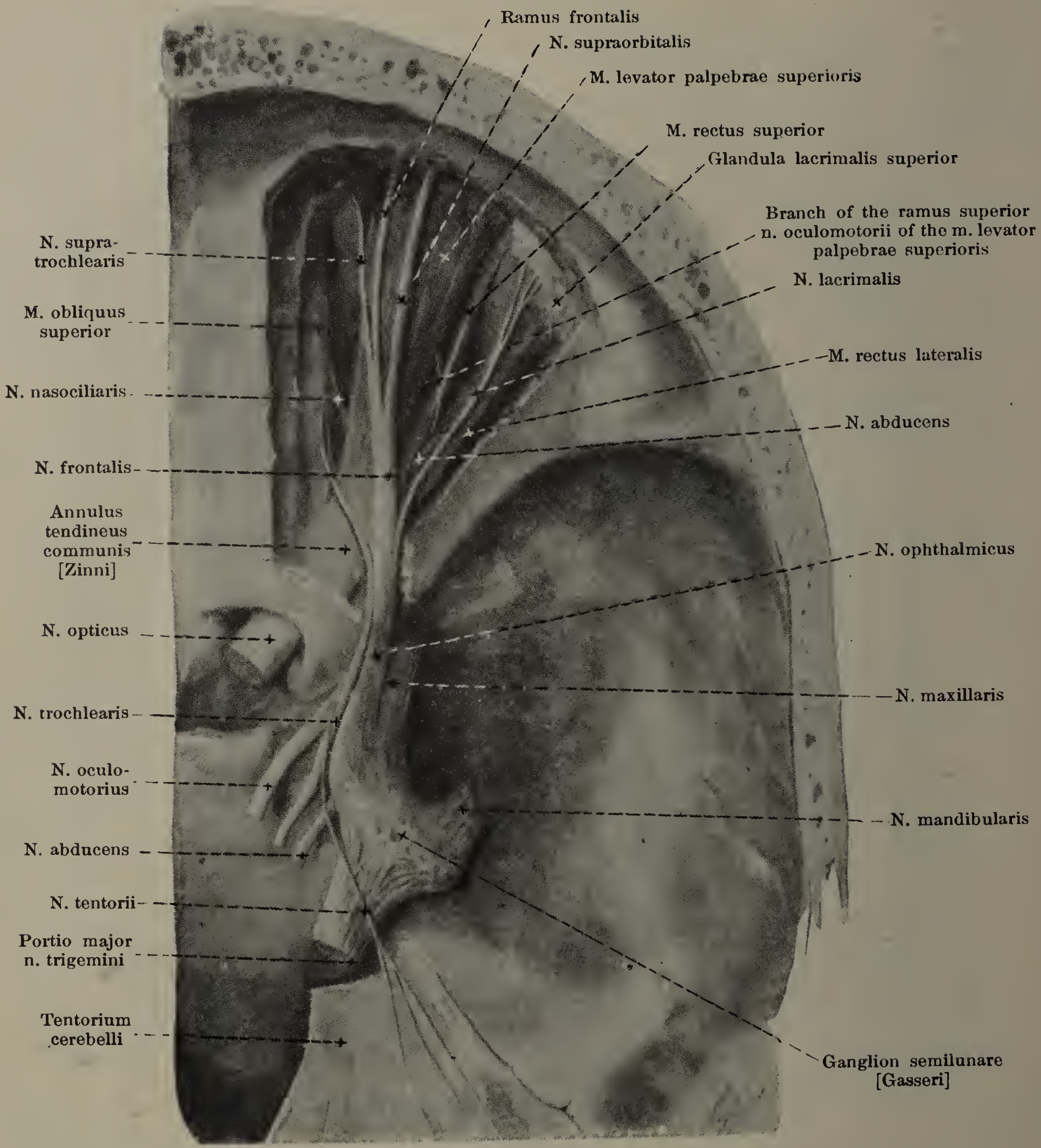
II. **N. opticus,** *visual nerve* (see Figs. 758, 817, 819, 822, 919 and 924), is a sensory nerve, but it is not comparable with the other cerebral nerves, since from its development and architecture it belongs to the brain and must be looked upon as a central intracerebral cord. It proceeds on each side from the anterior angle of the chiasma opticum (see p. 665) and, somewhat flattened, runs obliquely lateralward and forward to the foramen opticum, passes through this as a round cord along with the a. ophthalmica (see p. 415) and then extends obliquely to the posterior surface of the eye-ball (see p 795). In the horizontal direction it forms a slightly S-shaped curve, so as to be convex behind lateralward and in front medianward; in the vertical direction it presents a slight bayonet-like curve. It is surrounded by sheet-like processes of the meninges, and of the subdural and subarachnoidal spaces.

III. **N. oculomotorius** (see Figs. 748, 749, 758, 765, 817—819, 821—823, 915, 916 and 920—922), motor, emerges by a medial group of (on the average) 8 flat bundles from the sulcus n. oculomotorii (see p. 656) and by a very variable but approximately as large posterior, lateral group from the ventral surface of the cerebral peduncle (see Figs. 748 and 749). The root bundles converge and form a round cord, which passes forward and lateralward between the a. cerebelli superior and a. cerebri posterior (see Fig. 495), and perforates the dura mater lateral from the processus clinoideus posterior (see Figs. 817—819). It then runs forward and a little downward in the lateral wall of the sinus cavernosus (see Fig. 533), lateralward from the a. carotis interna; in this course it lies at first over the n. trochlearis and the n. ophthalmicus and is then crossed on its lateral surface by both of these, so that finally it reaches the fissura orbitalis superior below them, and passes within the annulus tendineus communis [Zinni] (see Figs. 819, 821—823, 915 and 916). There it divides immediately into two branches, a smaller, *ramus superior,* and a larger, *ramus inferior.*

a) *Ramus superior* (see Figs. 821 and 823) passes forward and upward lateral from the a. ophthalmica and from the n. opticus to the mm. rectus superior and levator palpebrae superioris.

b) *Ramus inferior* (see Figs. 822 and 823) divides into a branch which runs under the n. opticus to the m. rectus medialis, a short branch to the m. rectus inferior, and a long branch which passes along the lateral margin of the m. rectus inferior to the m. obliquus inferior. A short, thick thread, *radix brevis ganglii ciliaris,* runs from the latter to the posterior inferior part of the ganglion ciliare (see p. 714).

Anastomoses: In the sinus cavernosus it receives sympathetic fibres from the plexus cavernosus.

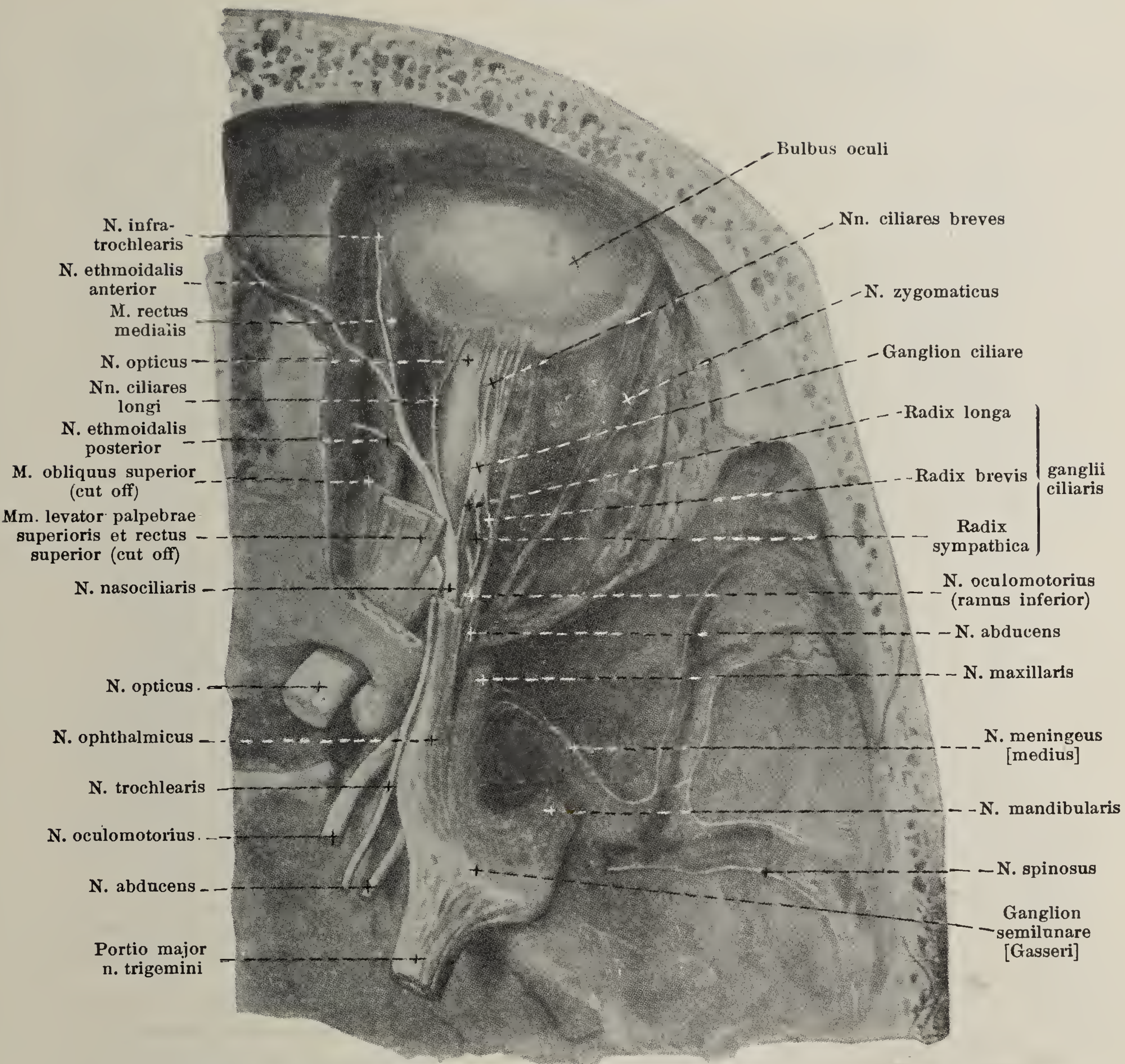


821. Nerves of the right orbital cavity,
viewed from above, 1st layer.

(The roof of the orbit has been removed and the fissura orbitalis superior partly exposed. The dura mater and the upper layer of the tentorium cerebelli have been dissected away.)

IV. **N. trochlearis** (see also Figs. 749, 750, 755, 757, 758, 817—820, 823, 833, 915, 916 and 919—921), motor, leaves the brain (see Fig. 757) on each side near the frenulum veli medullaris anterioris (see p. 655), runs (see Figs. 749, 750, 755, 757 and 758) as a delicate, curved cord along the upper margin of the pons, around the pedunculus cerebri, forward and perforates the dura mater lateral from the n. oculomotorius and below the most anterior jag of origin of the tentorium cerebelli (see Figs. 817—819). It then passes forward in the lateral wall of the sinus cavernosus (see also Fig. 533) under the n. oculomotorius and over the n. ophthalmicus, then crosses the former on its lateral side, goes through the fissura orbitalis superior outside the annulus tendineus communis [Zinni] (see also Figs. 915 and 916) and extends over the origin of the m. levator palpebrae superioris obliquely forward and medianward to the m. obliquus superior.

Anastomoses: In the sinus cavernosus it receives sympathetic fibres from the plexus cavernosus and usually anastomoses with the n. ophthalmicus (V).



822. Nerves of the right orbital cavity,
viewed from above. 2nd layer.

(Same preparation as in Fig. 821. In addition most of the eye muscles and the lateral wall of the orbit have been removed; the foramen ethmoidale anterius has been opened. The nn. meningeus and spinosus have been introduced according to *F. Arnold.)*

V. **N. trigeminus** (see also Figs. 749, 750, 755, 758, 817—821, 823—830 and 833), a mixed nerve, makes its appearance on the anterior surface of the pons (see p. 651) with two roots, the thick, sensory *portio major* and the thin, motor *portio minor*; the site of emergence of the round portio minor is somewhat rostral and dorsal from that of the flattened portio major (see Figs. 749, 750, 755 and 758). The portio minor loops around the medial margin of the portio major to its under surface; both pass forward and upward and perforate the dura mater beneath the line of departure of the tentorium cerebelli (and beneath the sinus petrosus superior) over the impressio trigemini of the pyramid of the temporal bone (see Figs. 817—819). Immediately in front of this spot, in a blind sack-like protrusion of the dura mater (see Fig. 819) the portio major becomes broader and goes over into the flat, sickle-shaped *ganglion semilunare [Gasseri]* (see also Figs. 758, 819—821 and 823); this lies adjacent to the a. carotis interna, lateral from the sinus cavernosus, over the foramen lacerum, or is separated from the artery by a thin layer of bone. On its under surface lie the nn. petrosi superficiales. The ganglion is similar in structure to the spinal ganglions and contains the cells of origin of the sensory fibres (see p. 698). The portio minor runs, on the inferior surface of the ganglion and without forming a nervous connection with it, to the n. mandibularis (see Figs. 758 and 820). The convexity of the ganglion is directed forward and downward, and from it diverge three branches: *n. ophthalmicus, n. maxillaris* and *n. mandibularis.*

a) ***N. ophthalmicus*** (see Figs. 819—823), sensory, the smallest branch, flattened, passes forward, upward and lateralward in the lateral wall of the sinus cavernosus (see also Fig. 533), where it lies beneath the n. trochlearis and lateral from the n. abducens, at first also beneath the n. oculomotorius, which passes forward on its medial side; it receives fine sympathetic threads from the plexus cavernosus and usually anastomoses with the n. trochlearis. In the sinus it gives off the fine *n. tentorii* (see Fig. 821) which passes backward at first close to the n. trochlearis, then runs to the tentorium cerebelli, and in it as far the sinuses. The n. ophthalmicus then enters the fissura orbitalis superior and divides, usually before its entrance, into three branches: *n. lacrimalis*, *n. frontalis* and *n. nasociliaris.*

1. *N. lacrimalis* (see Figs. 821,824,915,916 and 919—921), the finest branch, passes lateral from the n. frontalis (and annulus tendineus communis [Zinni]) into the orbital cavity, and runs close to the periorbita and over the m. rectus superior to the upper lachrymal gland, some threads passing through this to the conjunctiva and skin at the lateral angle of the eye; a fine connecting thread, *ramus anastomoticus cum n. zygomatico* (see Fig. 824), on the lateral wall of the orbit brings to it the secretory fibres for the lachrymal gland, which are believed to arise from the n. intermedius, to extend from the ganglion geniculi through the n. petrosus superficialis major to the ganglion sphenopalatinum and to pass from this into the n. maxillaris and the n. zygomaticus.

2. *N. frontalis* (see Figs. 821, 823, 832, 915, 916 and 919—922), the thickest branch, enters the orbital cavity lateral from the annulus tendineus communis between the n. trochlearis and the n. lacrimalis and runs forward over the m. levator palpebrae superioris. Branches:

α) *N. supraorbitalis*, the largest of them, goes forward in the direction of the main trunk and passes through the incisura supraorbitalis (or through the foramen supraorbitale) to the forehead. It sends numerous large branches to the skin of the forehead as far back as the vertex and some smaller branches to the skin and conjunctiva of the upper eyelid. One branch, running at the upper margin of the orbital cavity, unites with a branch of the n. facialis.

β) *Ramus frontalis*, forward and somewhat medianward to the incisura frontalis; it is distributed medial from the n. supraorbitalis and like it, to the forehead and upper eyelid.

γ) *N. supratrochlearis*, the finest branch, extends forward and medianward on the roof of the orbita and over the trochlea m. obliqui superioris to the upper eyelid, the root of the nose and the forehead. In front of the trochlea it anastomoses with the n. infratrochlearis.

3. *N. nasociliaris* (see Figs. 821—823, 915, 916 and 919—922) enters the orbit within the annulus tendineus communis [Zinni], runs at first between the m. rectus superior and the n. opticus forward and medianward, then forward between the mm. obliquus superior and rectus medialis and divides into the n. ethmoidalis anterior and n. infratrochlearis. Branches:

α) *Radix longa ganglii ciliaris*, slender, arises usually while still outside the orbital cavity and passes on the lateral side of the n. opticus and of the a. ophthalmica to the ganglion ciliare.

β) *Nn. ciliares longi*, usually two, on the medial side of the n. opticus to the eyeball (see p. 802).

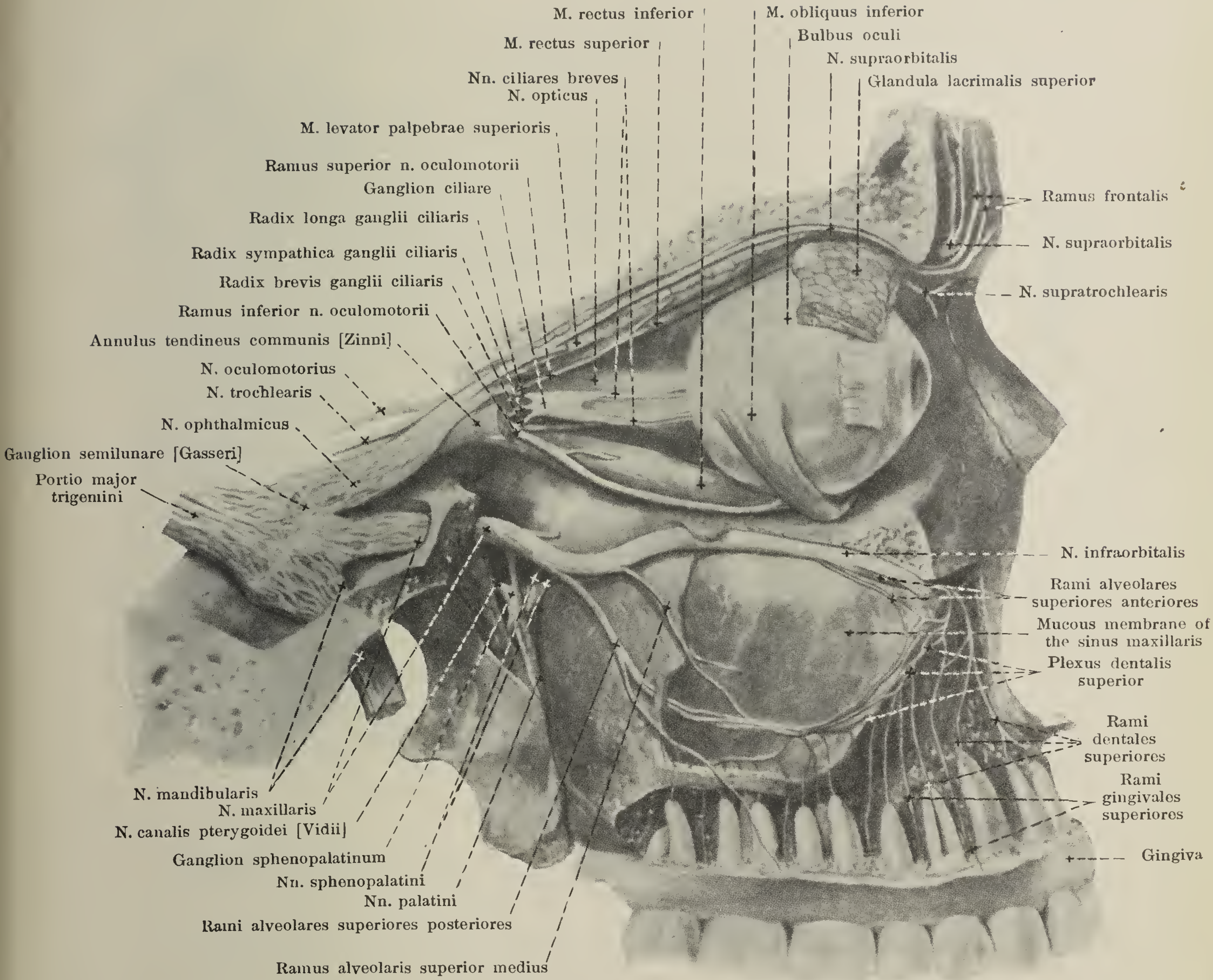
γ) *N. ethmoidalis posterior*, very fine, passes through the foramen ethmoidale posterius to the mucous membrane of the posterior ethmoidal cells and of the sphenoidal sinuses.

δ) *N. ethmoidalis anterior* goes through the foramen ethmoidale anterius upon the upper surface of the lamina cribrosa, gives there a fine branch near the a. meningea anterior to the dura mater and the falx cerebri, then perforates the lamina cribrosa and divides into several *rami nasales anteriores.* Of these, the *rami nasales interni* go to the mucous membrane of the anterior part of the septum *(rami nasales mediales*, see Fig. 826) and to the lateral wall of the nasal cavity *(rami nasales laterales*, see Fig. 825); the *ramus nasalis externus* (see Fig. 825) runs first behind the spina frontalis, then in the sulcus ethmoidalis of the nasal bone, passes outward between the nasal bone and the nasal cartilage, and supplies the skin of the tip of the nose and of the alae nasi (see Fig. 832).

ε) *N. infratrochlearis* passes forward under the m. obliquus superior and divides (see Fig. 832) under its trochlea into a *ramus palpebralis superior*, which helps to supply the eyelids and usually anastomoses with the n. supratrochlearis, and a *ramus palpebralis inferior* to the tear-sack, caruncula lacrimalis, eyelids and nose.

Ganglion ciliare (see Figs. 822 and 823) a sympathetic ganglion, lies as a small, oblong-quadrangular, flattened disk, on the lateral surface of the n. opticus. At its posterior margin it is united: 1. at the inferior angle with the n. oculomotorius by means of the short, thick *radix brevis* (see p. 711), 2. at the upper angle with the n. nasociliaris (vide supra) by the long, delicate *radix longa* and 3. with the plexus cavernosus by the delicate *radices sympathicae.* From its anterior margin 3—6 *nn. ciliares breves* go to the eyeball (see p. 802).

b) ***N. maxillaris*** (O. T. superior maxillary) (see Figs. 822—826), sensory, passes flattened forward in the lateral wall of the sinus cavernosus (see also Fig. 533) to the foramen rotundum, runs through this as a round cord, extends obliquely forward, lateralward and downward through the uppermost part of the fossa pterygopalatina over the end extremity of the a. maxillaris interna to the sulcus and canalis infraorbitalis and from there on is known as the *n. infraorbitalis.*


M. rectus inferior
M. obliquus inferior
Bulbus oculi
M. rectus superior
N. supraorbitalis
Glandula lacrimalis superior
Nn. ciliares breves
N. opticus
M. levator palpebrae superioris
Ramus superior n. oculomotorii
Ganglion ciliare
Ramus frontalis
Radix longa ganglii ciliaris
N. supraorbitalis
Radix sympathica ganglii ciliaris
Radix brevis ganglii ciliaris
N. supratrochlearis
Ramus inferior n. oculomotorii
Annulus tendineus communis [Zinni]
N. oculomotorius
N. trochlearis
N. ophthalmicus
Ganglion semilunare [Gasseri]
Portio major trigemini
N. infraorbitalis
Rami alveolares superiores anteriores
Mucous membrane of the sinus maxillaris
Plexus dentalis superior
Rami dentales superiores
Rami gingivales superiores
N. mandibularis
N. maxillaris
N. canalis pterygoidei [Vidii]
Gingiva
Ganglion sphenopalatinum
Nn. sphenopalatini
Nn. palatini
Rami alveolares superiores posteriores
Ramus alveolaris superior medius

823. Nerves of the right orbit and the upper jaw,
viewed from the right.

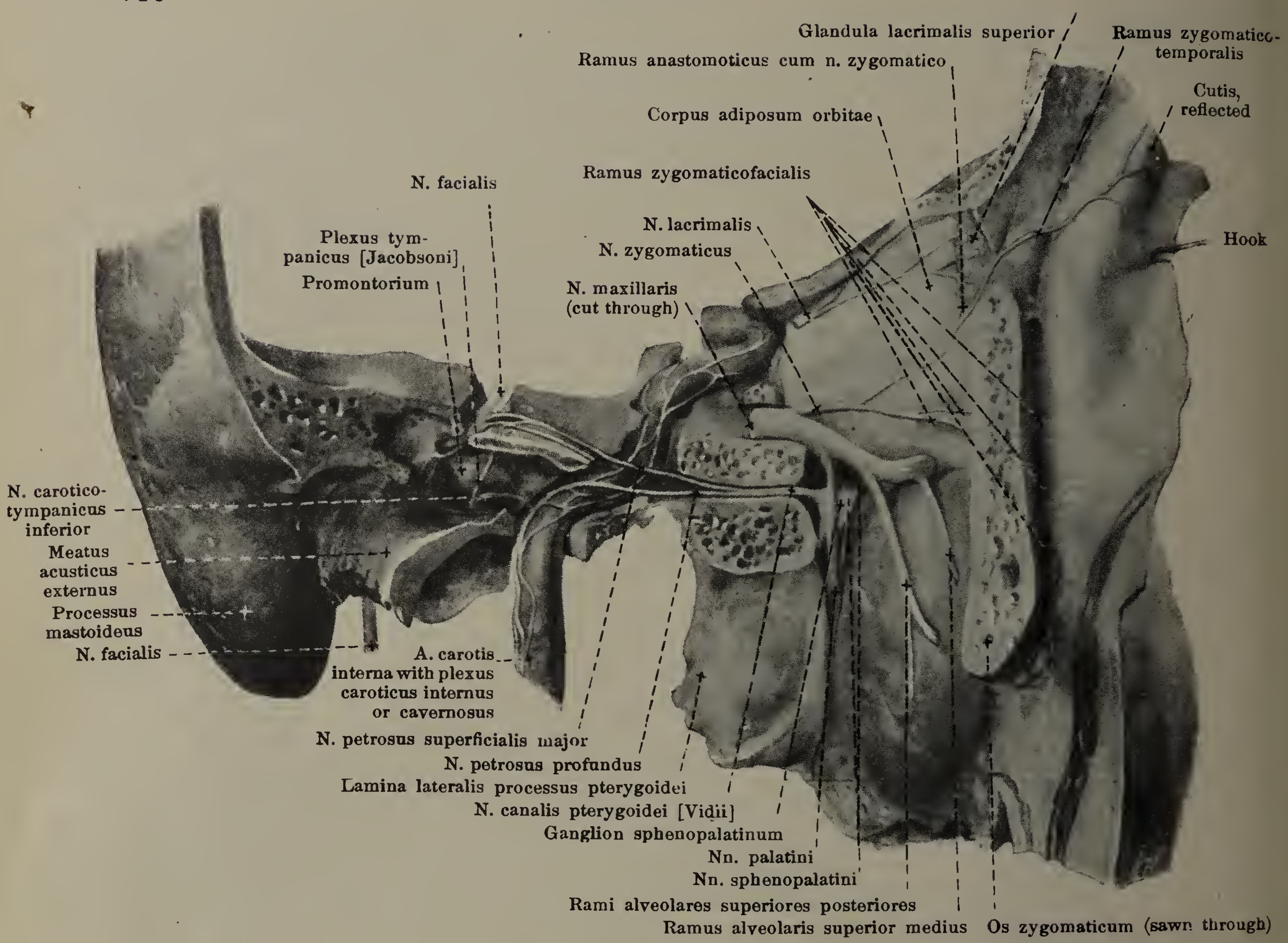
(The lateral wall of the orbit have been completely removed, the upper wall of the orbit as well as the wall of the upper jaw partly; the m. rectus oculi lateralis has also been removed.)

b) ***N. maxillaris*** (see also Figs. 822 and 824—826) (continued). Within the skull cavity it gives of the fine *n. meningeus [medius]* (see Fig. 822), which passes lateralward to the anterior branch of the a. meningea media, breaks up in the dura mater in its neighborhood and anastomoses with the n. spinosus (see p. 719). Outside the skull cavity the following branches are given off:

1. *N. zygomaticus* (see Figs. 822 and 824), a small branch from the upper margin within the fossa pterygopalatina, runs lateralward in the connective tissue closing the fissura orbitalis inferior and then passes forward along the lateral wall of the orbit. Branches:

α) *Ramus zygomaticotemporalis*, the upper of the two, gives off a fine communicating thread to the n. lacrimalis (see p. 714), passes through a foramen zygomaticoorbitale into the yoke-bone, and leaves this again through the foramen zygomaticotemporale; it thus arrives in the temporal fossa, and thence, usually divided into two branches, extends over the upper margin of the yoke-bone, through the fascia temporalis to the skin of the temporal region (see Figs. 824 and 832). It anastomoses manifoldly with its own twigs or with those of neighboring branches and varies much in its distribution.

β) *Ramus zygomaticofacialis*, sometimes doubled, runs from a foramen zygomaticoorbitale to the foramen zygomaticofaciale through a canaliculus of the yoke-bone to the facies malaris of the latter and spreads out in the skin in the anterior part of the yoke-bone region and at the lateral angle of the eye (see Figs. 824, 828 and 832).


Glandula lacrimalis superior
Ramus zygomatico-temporalis
Ramus anastomoticus cum n. zygomatico
Cutis, reflected
Corpus adiposum orbitae
Ramus zygomaticofacialis
N. facialis
Hook
N. lacrimalis
Plexus tympanicus [Jacobsoni]
N. zygomaticus
Promontorium
N. maxillaris (cut through)
N. caroticotympanicus inferior
Meatus acusticus externus
Processus mastoideus
N. facialis
A. carotis interna with plexus caroticus internus or cavernosus
N. petrosus superficialis major
N. petrosus profundus
Lamina lateralis processus pterygoidei
N. canalis pterygoidei [Vidii]
Ganglion sphenopalatinum
Nn. palatini
Nn. sphenopalatini
Rami alveolares superiores posteriores
Ramus alveolaris superior medius
Os zygomaticum (sawn through)

824. Right nervus canalis pterygoidei [Vidii], viewed from the right.

(The lateral wall of the orbit has been for the most part removed; the canales pterygoideus [Vidii], caroticus et facialis and the tympanic cavity have been exposed.)

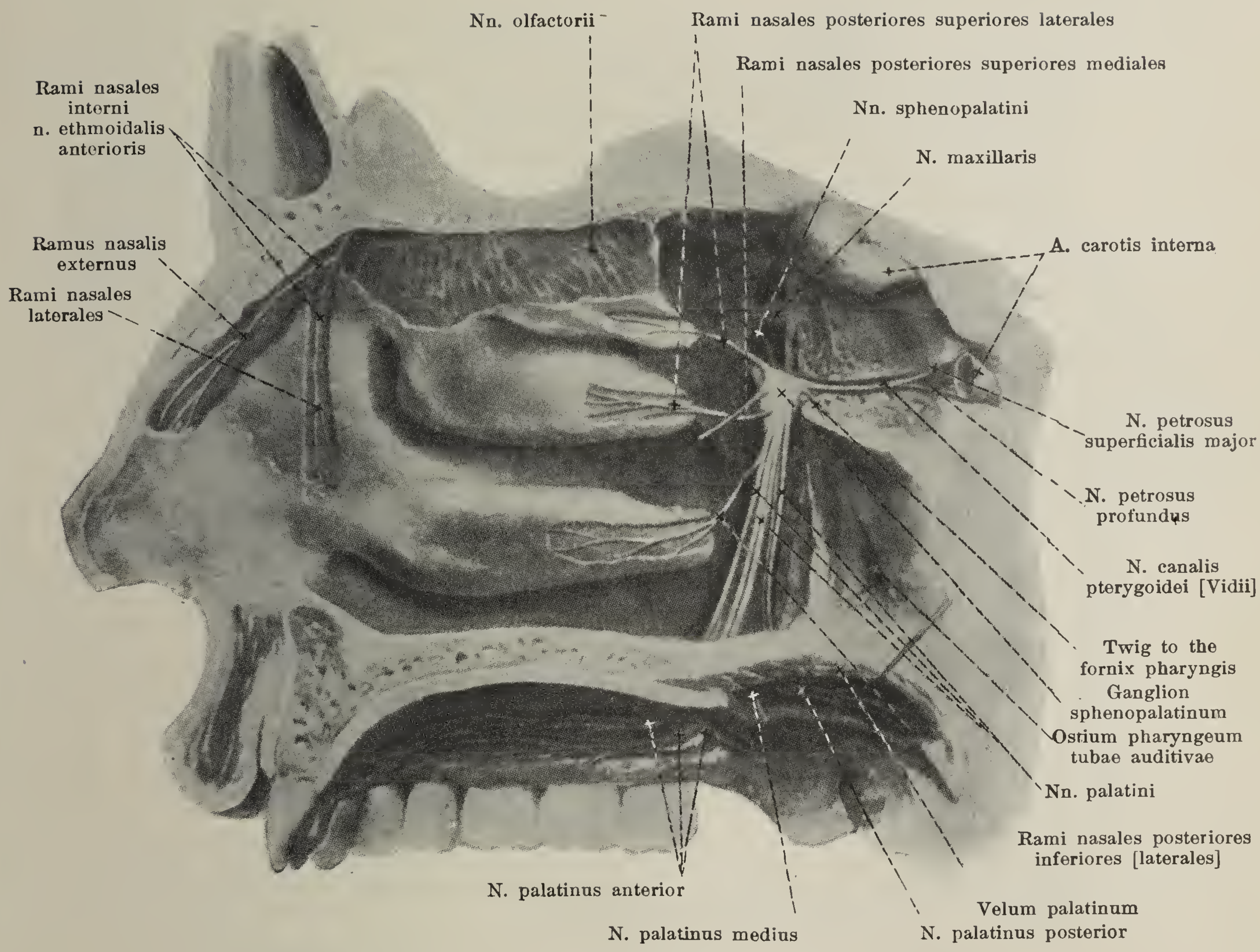
2. *Nn. sphenopalatini* (see also Figs. 823 and 825), two or three, sometimes single, go downward in the fossa pterygopalatina from the lower margin of the n. maxillaris. A very small part of their fibres. sometimes interwoven, enters the ganglion sphenopalatinum; the largest part, however, passes on its lateral surface or in front of it and goes over directly into the rami orbitales, rami nasales posteriores and nn. palatini, which are usually designated as branches of the ganglion (see p. 718).

3. *Nn. alveolares superiores* (see also Fig. 823) arise partly from the n. maxillaris, partly from the n. infraorbitalis (see p. 717).

α) *Rami alveolares superiores posteriores*, usually two, arising a little before the entrance into the orbit, run downward and forward upon the facies infratemporalis maxillae and pass through the foramina alveolaria into the canales alveolares and help to form the plexus dentalis superior (vide infra).

β) *Ramus alveolaris superior medius* is given off from the n. infraorbitalis in the posterior part of the canalis infraorbitalis and passes downward and forward in a special bony canal of the lateral wall of the maxilla to the middle part of the plexus dentalis superior (vide infra).

γ) *Rami alveolares superiores anteriores*, given off from the n. infraorbitalis close behind the foramen infraorbitale, run downward in the canales alveolares of the anterior wall of the maxilla. With the other rami alveolares within the canales alveolares they form a plexus, *plexus dentalis superior*, which is curved so as to be convex downward; this anastomoses with that of the other side. From it arise *rami dentales superiores* to the roots of the individual teeth, *rami gingivales superiores* to the gums, as well as branches to the bone and to the mucous membrane of the sinus maxillaris.


Nn. olfactorii
Rami nasales posteriores superiores laterales
Rami nasales posteriores superiores mediales
Nn. sphenopalatini
N. maxillaris
Rami nasales interni n. ethmoidalis anterioris
Ramus nasalis externus
Rami nasales laterales
A. carotis interna
N. petrosus superficialis major
N. petrosus profundus
N. canalis pterygoidei [Vidii]
Twig to the fornix pharyngis
Ganglion sphenopalatinum
Ostium pharyngeum tubae auditivae
Nn. palatini
Rami nasales posteriores inferiores [laterales]
N. palatinus anterior
N. palatinus medius
Velum palatinum
N. palatinus posterior

825. Nerves of the right lateral wall of the nose.

(The fossa pterygopalatina and the canales palatini have been exposed from inside.)

4. The *n. infraorbitalis* (see p. 714), usually a flat plexus, perforated at the beginning of the canalis infraorbitalis by the a. infraorbitalis, leaves the canalis infraorbitalis through the foramen infraorbitale and divides there quickly into its terminal branches (see Figs. 828 and 832), which partly unite with branches of the n. facialis. The terminal branches are:

α) *Rami palpebrales inferiores,* several delicate branches, go through the caput infraorbitale of the m. quadratus labii superioris to the skin of the lower eyelid and of the two angles of the eye.

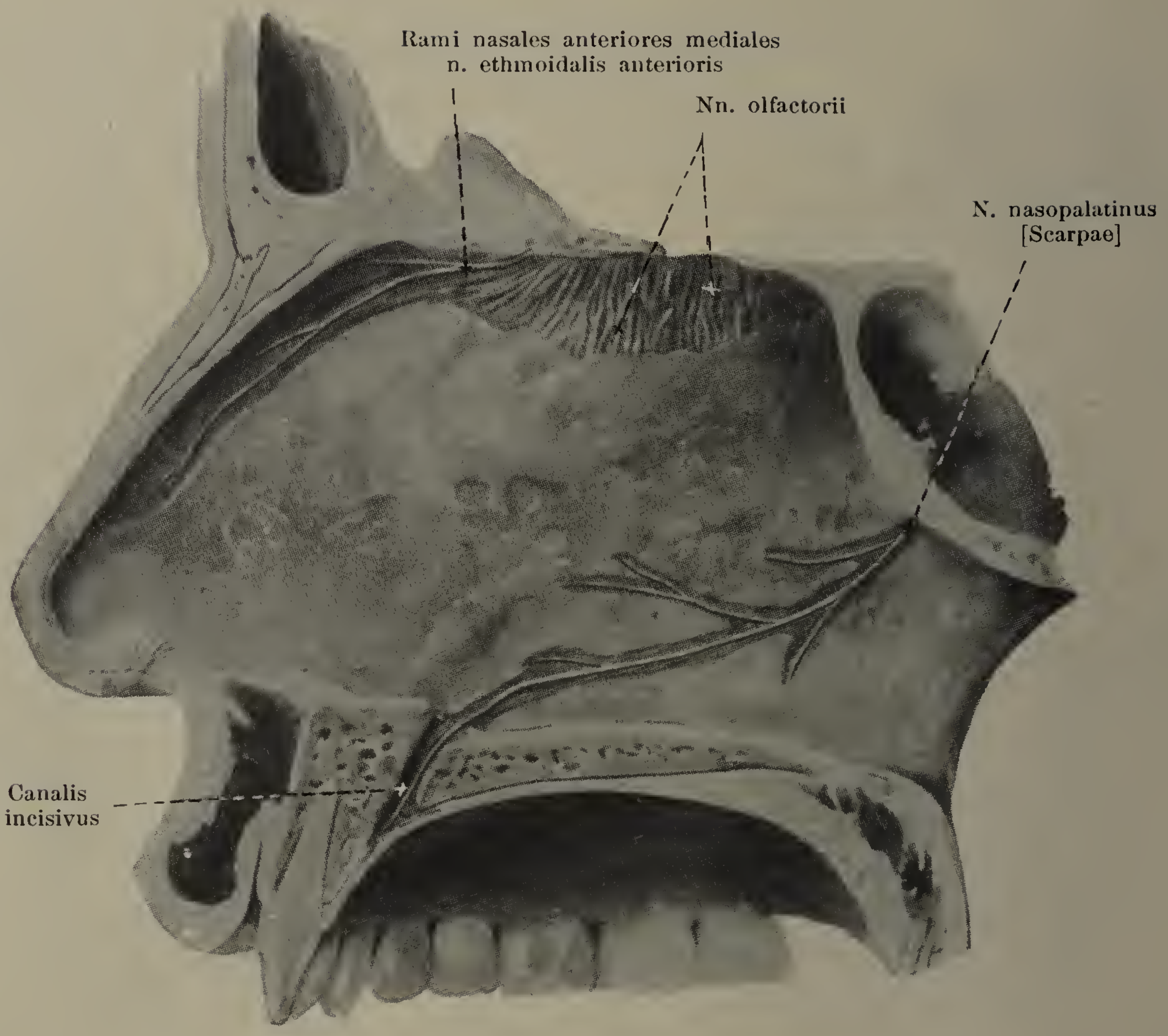
β) *Rami nasales,* 2—3, run upon the m. nasalis to the skin of the ala nasi *(rami nasales externi)* and of the septum mobile nasi *(rami nasales interni).*

γ) *Rami labiales superiores,* 3—4, pass between the m. quadratus labii superioris and the m. caninus downward to the skin and mucous membrane of the upper lip and to the gums.

Ganglion sphenopalatinum (see also Figs. 823 and 824) is a sympathetic ganglion (see p. 788) and lies as a small, flattened wedge, with its apex behind, in the fossa pterygopalatina, just in front of the anterior opening of the canalis pterygoideus [Vidii], a few millimeters below and medianward from the n. maxillaris. The following are usually designated as its *roots:*

1. *N. canalis pterygoidei [Vidii],* enters the posterior apex of the ganglion, runs in the canalis pterygoideus [Vidii], there arising through the union of two threads:

α) *N. petrosus superficialis major* (see also Figs. 824, 829 and 831) comes off from the n. facialis at the ganglion geniculi (see p. 724), anastomoses with the n. petrosus superficialis minor (see Fig. 831) and arrives through the hiatus canalis facialis in the sulcus n. petrosi superficialis majoris of the temporal bone. It then passes lateral from the a. carotis interna through the fibrocartilago basalis, filling up the foramen lacerum, to the canalis pterygoideus. In this branch run certainly the sensory and perhaps also the taste fibres of the anterior two-thirds of the tongue (see p. 723); in addition it carries the secretory fibres for the lachrymal gland (see p. 714).



826. Nerves of the nasal septum, viewed from the left.

Ganglion sphenopalatinum (see Figs. 823—825) (continued):

β) *N. petrosus profundus* (see Fig. 824) arises from the sympathetic plexus caroticus internus, woven around the a. carotis interna, from the horizontal part of the artery, and goes through the fibrocartilago basalis to the posterior opening of the canalis pterygoideus.

2. Fibres of the *nn. sphenopalatini,* which connect the ganglion with the n. maxillaris (see p. 716).

The following nerves are usually mentioned as *branches* of the ganglion, although they are, for the most part, direct branches of the nn. sphenopalatini (see p. 716) and are only strengthened by a variable number of threads from the ganglion.

1. *Rami orbitales* (not illustrated), 2—3 extremely fine threads, which pass through the fissura orbitalis inferior into the orbital cavity and through the foramen ethmoidale posterius or special small openings to the mucous membrane of the ethmoidal cells and sphenoidal sinus.

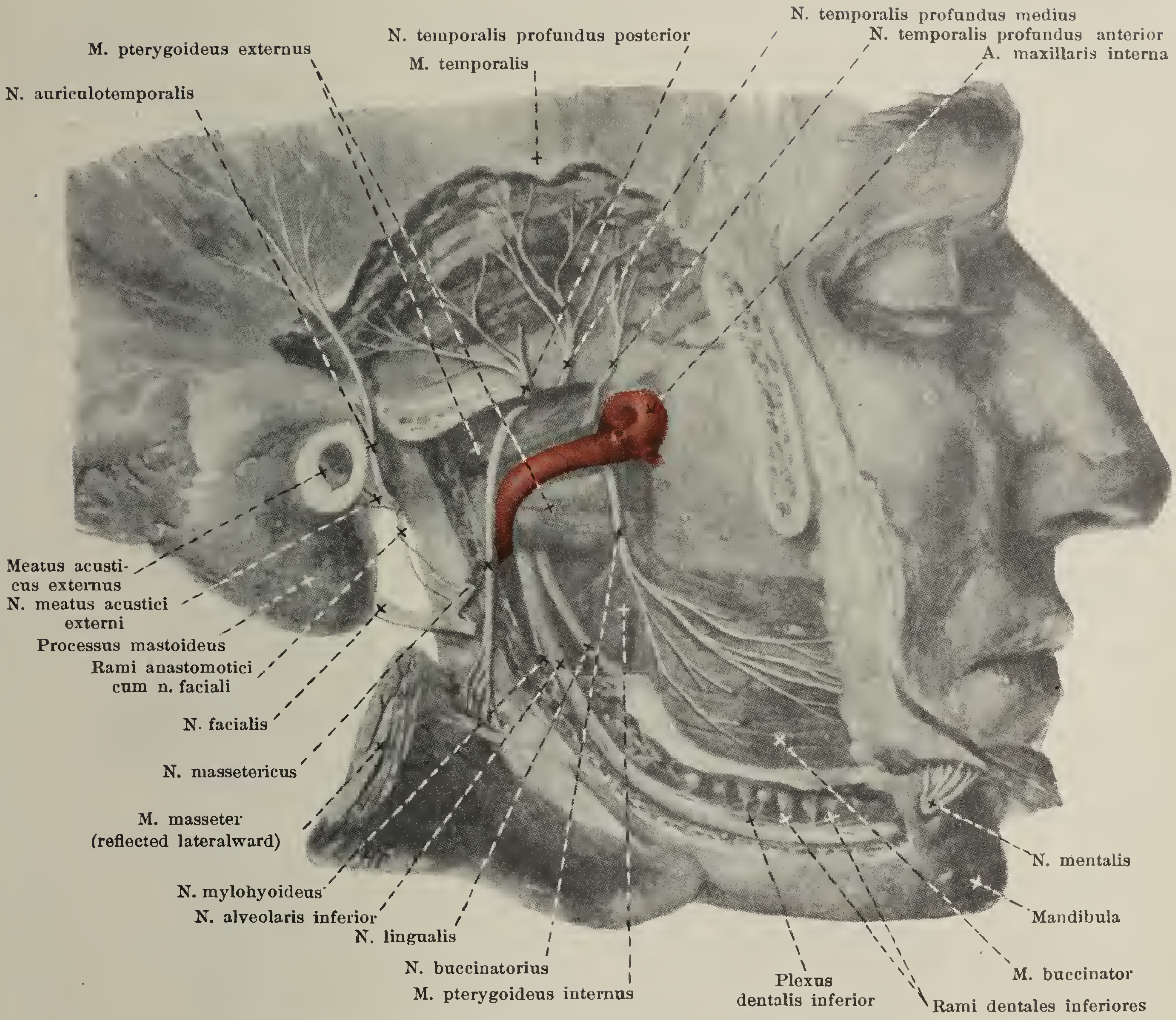
2. *Rami nasales posteriores superiores* (see also Fig. 825), several fine threads, enter the nasal cavity through the foramen sphenopalatinum, and, as *rami laterales,* arrive in the mucous membrane of the upper and middle nasal conchae (some also through the canales pharyngeus and basipharyngeus to the fornix pharyngis and ostium pharyngeum tubae auditivae), as *rami mediales* on the inferior surface of the body of the sphenoid bone to the nasal septum; of the latter the largest, *n. nasopalatinus [Scarpae],* extends forward and downward on the septum to the canalis incisivus, anastomoses with that of the other side and ends in the mucous membrane of the hard palate.

3. *Rami nasales posteriores inferiores [laterales]* (see Fig. 825), usually branches of the n. palatinus anterior (vide infra), pass through small openings in the pars perpendicularis oss. palatini into the nasal cavity and to the mucous membrane of the inferior concha.

4. *Nn. palatini* (see Figs. 823—825) run downward through the canalis pterygopalatinus and the canales palatini, dividing into three branches:

α) *N. palatinus anterior,* the largest, passes through the foramen palatinum majus on the inferior surface of the hard palate, passes forward on it, divided in several branches, and supplies the mucous membrane of the soft and hard palate and the gums.

β) *N. palatinus medius,* the smallest, goes through a foramen palatinum minus to the mucous membrane of the soft palate and to the region of the tonsil.



827. Branches of the right n. mandibularis (V), more superficial layer, viewed from the right.

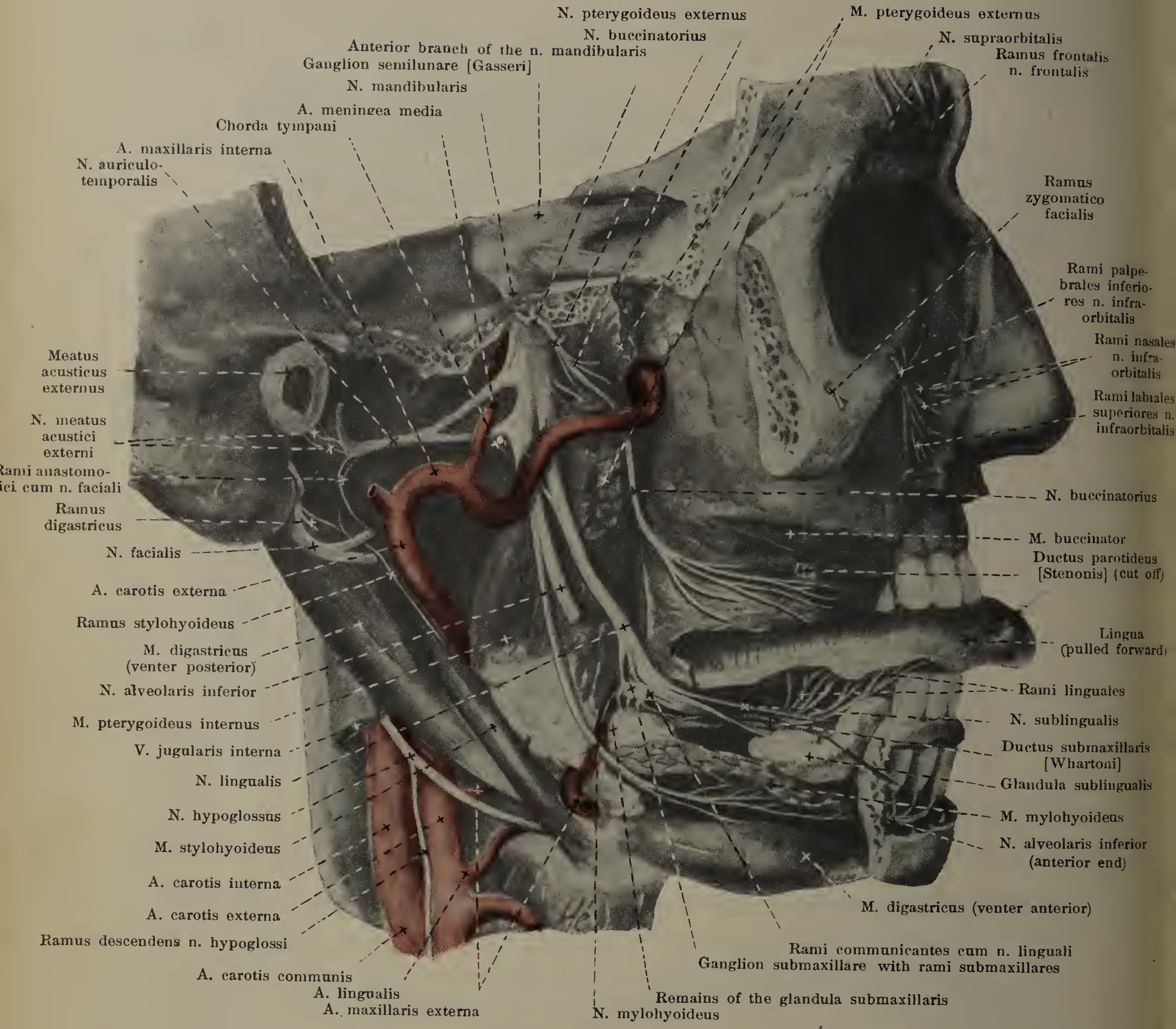
(The arcus zygomaticus and the proc. coronoideus mandibulae have been removed; the canalis mandibulae has been chiseled open; the m. masseter has been reflected lateralward.)

Ganglion sphenopalatinum (see Fig. 825) (continued):

g) *N. palatinus posterior* goes through a foramen palatinum minus and then passes backward to the mucous membrane of the inferior surface of the soft palate.

c) ***N. mandibularis*** (O. T. inferior maxillary) (see also Figs. 820, 822, 823, 828, 829 and 834), a mixed nerve, the largest branch, is formed of the (sensory) inferior division of the ganglion semilunare [Gasseri] and of the smaller (motor) portio minor (see p. 713), which are partly interwoven with one another beneath the ganglion. It runs downward through the foramen ovale (surrounded by the venous rete foraminis ovalis) and immediately beneath the same gives off the delicate *n. spinosus* (see Figs. 822 and 829), which receives a strand from the ganglion oticum (see p. 723), goes backward again into the skull cavity through the foramen spinosum with the a. meningea media and arrives along with the branches of the artery to the dura mater of the great wing of the sphenoidal bone and the mastoid cells.

The n. mandibularis divides into a smaller anterior and a larger posterior branch. The *anterior* branch is chiefly motor; into it almost the whole portio minor goes and is continued into the pure motor *nn. massetericus, temporales profundi, pterygoideus externus* (all these together with the n. pterygoideus internus, being designated as the *n. masticatorius);* it contains only a few fibres which are not motor, viz., the pure sensory *n. buccinatorius.*

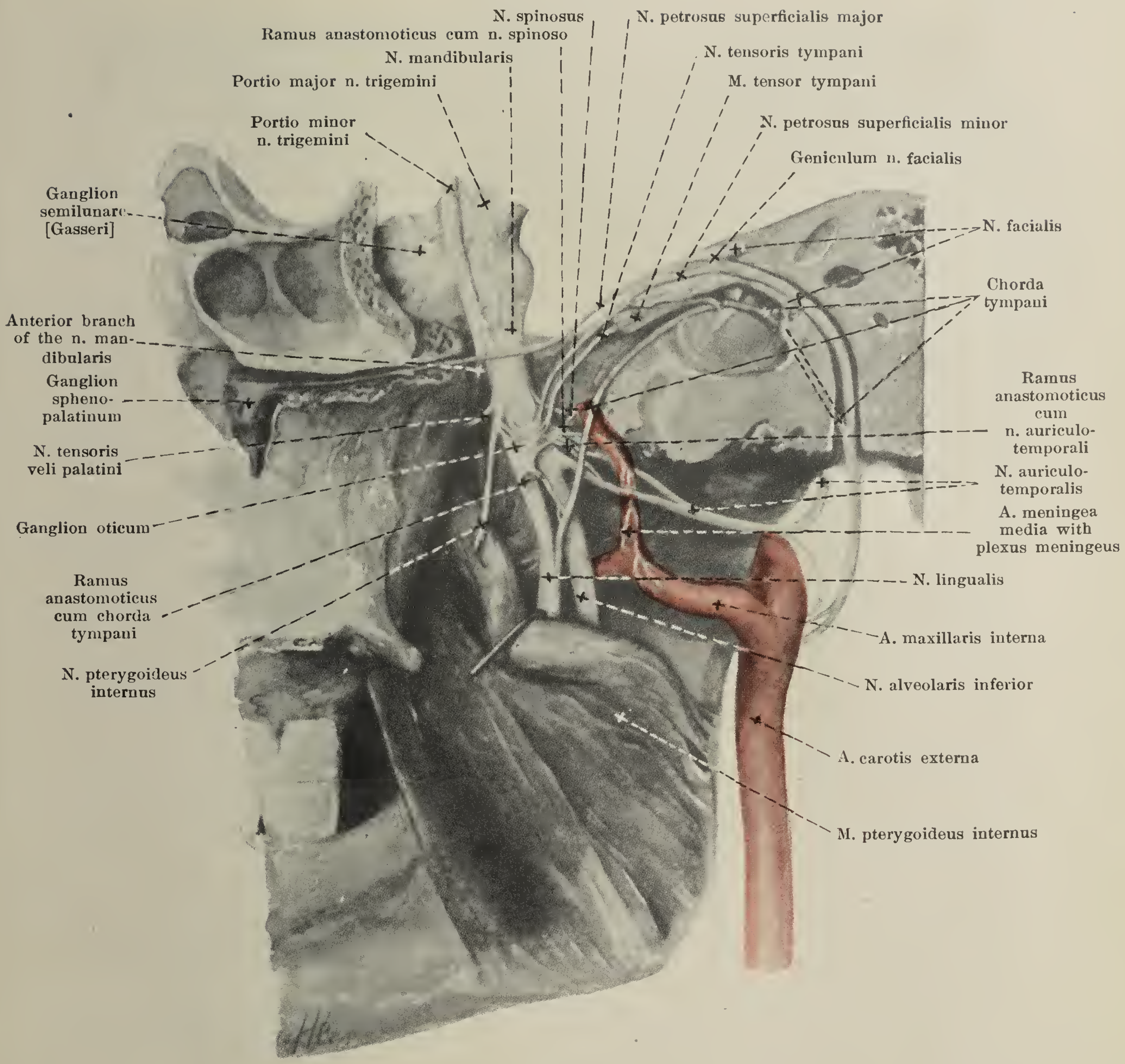

N. pterygoideus externus
N. buccinatorius
Anterior branch of the n. mandibularis
Ganglion semilunare [Gasseri]
N. mandibularis
A. meningea media
Chorda tympani
A. maxillaris interna
N. auriculo-temporalis
M. pterygoideus externus
N. supraorbitalis
Ramus frontalis n. frontalis
Ramus zygomatico facialis
Rami palpebrales inferiores n. infraorbitalis
Rami nasales n. infraorbitalis
Rami labiales superiores n. infraorbitalis
Meatus acusticus externus
N. meatus acustici externi
Rami anastomo-
ici cum n. faciali
Ramus digastricus
N. facialis
A. carotis externa
Ramus stylohyoideus
M. digastricus (venter posterior)
N. alveolaris inferior
M. pterygoideus internus
V. jugularis interna
N. lingualis
N. hypoglossus
M. stylohyoideus
A. carotis interna
A. carotis externa
Ramus descendens n. hypoglossi
A. carotis communis
A. lingualis
A. maxillaris externa
N. buccinatorius
M. buccinator
Ductus parotideus [Stenonis] (cut off)
Lingua (pulled forward)
Rami linguales
N. sublingualis
Ductus submaxillaris [Whartoni]
Glandula sublingualis
M. mylohyoideus
N. alveolaris inferior (anterior end)
M. digastricus (venter anterior)
Rami communicantes cum n. linguali
Ganglion submaxillare with rami submaxillares
Remains of the glandula submaxillaris
N. mylohyoideus

828. Branches of the right n. mandibularis (V), deeper layer, viewed from the right.

(Like Fig. 827, but the lower jaw and masticatory muscles have been almost completely removed; all but a small part of the glandula submaxillaris has been removed.)

c) ***N. mandibularis*** (see also Figs. 827, 829 and 834) (continued): The *posterior* branch is almost exclusively sensory; it carries only a few motor fibres to the pure motor *n. pterygoideus internus*, *n. tensoris veli palatini*, *n. tensoris tympani* and *n. mylohyoideus;* the latter is a branch of the *n. alveolaris*, which otherwise contains only sensory fibres, and together with the pure sensory *nn. auriculotemporalis* and *lingualis* makes up the main mass of sensory fibres of the n. mandibularis. The posterior branch is united by (usually two) short, fine threads with the upper margin of the ganglion oticum (see p. 723).

1. *N. massetericus* (see Fig. 827) arises usually with the n. temporalis profundus posterior, passes horizontally lateralward on the facies infratemporalis of the sphenoid bone, above the m. pterygoideus externus, and then runs lateralward and downward through the incisura mandibulae to the medial surface of the m. masseter; it gives off 1—2 threads for the joint of the jaw.


N. spinosus
N. petrosus superficialis major
Ramus anastomoticus cum n. spinoso
N. mandibularis
N. tensoris tympani
Portio major n. trigemini
M. tensor tympani
Portio minor n. trigemini
N. petrosus superficialis minor
Geniculum n. facialis
Ganglion semilunare [Gasseri]
N. facialis
Chorda tympani
Anterior branch of the n. mandibularis
Ganglion spheno-palatinum
Ramus anastomoticus cum n. auriculo-temporali
N. tensoris veli palatini
N. auriculo-temporalis
Ganglion oticum
A. meningea media with plexus meningeus
Ramus anastomoticus cum chorda tympani
N. lingualis
A. maxillaris interna
N. pterygoideus internus
N. alveolaris inferior
A. carotis externa
M. pterygoideus internus

829. Right ganglion oticum, viewed from within.

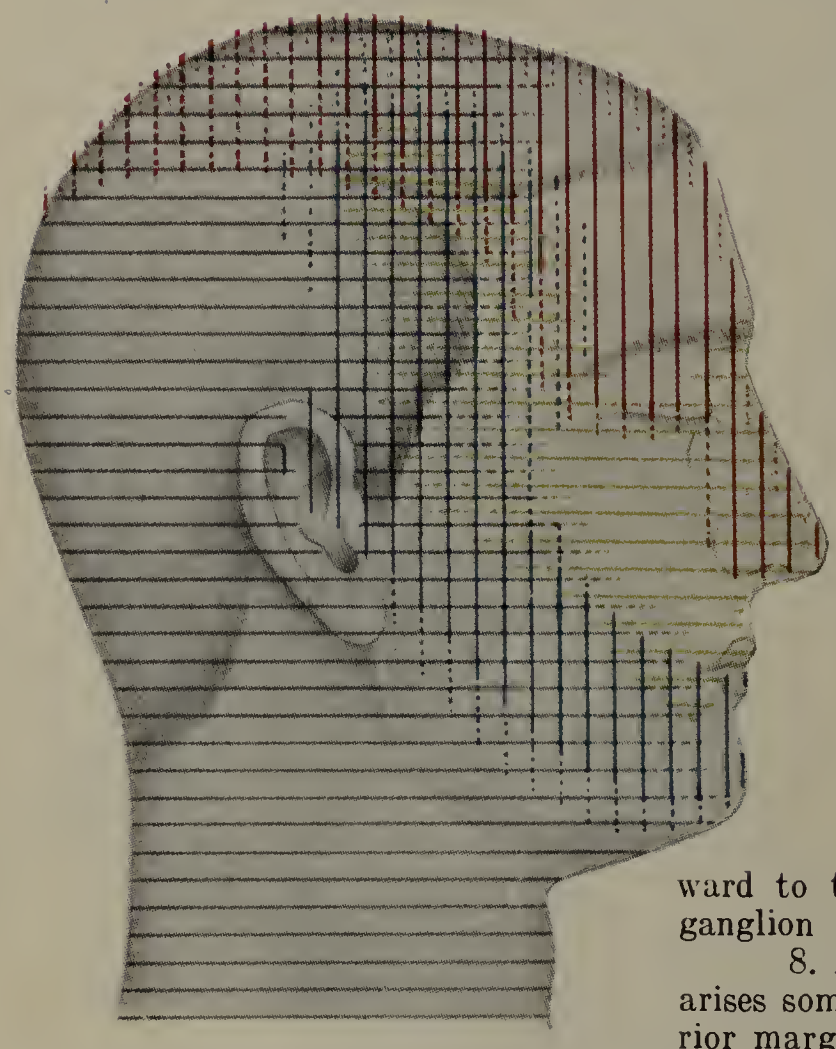
(From one portion of a head cut in half the viscera and spine have been removed; the internal ear and the apex of the pyramid of the temporal bone have been cut away.)

2. *Nn. temporales profundi* (see Fig. 827), usually three, a *posterior, medius* and *anterior,* of which the middle one may be absent; the posterior usually arises in common with the n. massetericus, the anterior with the n. buccinatorius. They run at first horizontally lateralward like the n. massetericus (see p. 720) (the anterior often between the two heads of the m. pterygoideus externus), then bend vertically upward and finally break up, anastomosing with one another in the m. temporalis.

3. *N. buccinatorius* (see Figs. 827, 828 and 832) (see also above) passes downward, forward and lateralward, either between the two heads of the m. pterygoideus externus or between the two mm. pterygoidei, arrives upon the lateral surface of the m. buccinator and there anastomoses with branches of the n. facialis. It sends branches through the m. buccinator to the mucous membrane of the cheek and is distributed also to the skin of the angle of the mouth; there fore it is a pure sensory nerve.

4. *N. pterygoideus externus* (see Figs. 828) arises almost always in common with the n. buccinatorius and runs downward and lateralward to the m. pterygoideus externus.

5. *N. pterygoideus internus* passes near the ganglion oticum or through it, connected with it by fine threads, downward to the medial surface of the m. pterygoideus internus.



830. Domains of distribution of the branches of the n. trigeminus and of the plexus cervicalis in the skin of the head, after R. Zander. Red: n. ophthalmicus; yellow: n. maxillaris; blue: n. mandibularis; black: branches of the plexus cervicalis.

(The regions which are regularly supplied by the nerves concerned are indicated by solid lines, those not regularly supplied by dotted lines.)

6. *N. tensoris veli palatini* (see Fig. 829), usually a branch of the foregoing, runs forward and downward to the m. tensor veli palatini; it is connected with the ganglion oticum by a fine thread.

7. *N. tensoris tympani* (see Fig. 829), usually a branch of the n. pterygoideus internus, very fine, passes backward and upward to the m. tensor tympani; it is connected with the ganglion oticum by a delicate thread.

8. *N. auriculotemporalis* (see Figs. 827—829 and 832) arises somewhat beneath the foramen ovale from the posterior margin of the n. mandibularis, usually by two roots, which include the a. meningea media between them and then unite. It runs at first backward and somewhat downward on the medial surface of the m. pterygoideus externus and processus condyloideus mandibulae above the a. maxillaris interna, bends around the collum proc. condyloidei, first lateralward, then upward through the substance of the glandula parotis in front of the cartilaginous external acoustic meatus, to pass finally, behind the a. temporalis superficialis, in a vertical direction to the skin of the temple. It is united by several threads with the ganglion oticum (see p. 723); these lead to it the secretory fibres of the glandula parotis, which come through the n. petrosus superficialis minor (see p. 723) and the n. tympanicus (see p. 730 and Fig. 831) from the n. glossopharyngeus leaving the brain with the latter. It gives off 1—2 fine threads to the joint of the jaw, and in addition:

- α) *Rami anastomotici cum n. faciali* (see Figs. 827, 828 and 833), usually two, go off behind the collum proc. condyloidei and pass forward through the parotid gland to the upper terminal branch of the n. facialis; they contain sensory fibres which run peripherally with the branches of the n. facialis.
- β) *Rami parotidei* (not illustrated) from the main stem or from the preceding to the parotid gland; they carry the secretory fibres to it which arise from the ganglion oticum (vide supra).
- γ) *Nn. meatus acustici externi* (see Figs. 827 and 828), usually two, run backward, penetrate at the junction between the cartilaginous and bony external acoustic meatus into the latter, supply its skin and send a fine branch, *ramus membranae tympani,* to the ear-drum membrane.
- δ) *Nn. auriculares anteriores* (see Fig. 832) to the skin of the anterior part of the auricle.
- ε) *Rami temporales superficiales* (see Fig. 832), usually two, to the skin of the temple; they anastomose above with branches of the nn. ophthalmicus (V) and occipitalis major and alternate in their distribution with the n. zygomaticotemporalis.

9. *N. alveolaris inferior* (see Figs. 827—829), the largest branch, passes first on the medial surface of the m. pterygoideus externus and of the a. maxillaris interna, then between the ramus mandibulae and the m. pterygoideus internus, slightly curved, downward to the foramen mandibulare and thence forward in the canalis mandibulae with the a. and v. alveolaris. It gives off the following branches:

- α) *N. mylohyoideus* (see Figs. 827 and 828) goes off close above the foramen mandibulare and passes downward and forward in the sulcus mylohyoideus mandibulae, at first lateral from the m. pterygoideus internus, then beneath the m. mylohyoideus; it supplies the latter and the venter anterior m. digastrici.
- β) *Rami dentales inferiores* (see Fig. 827) and *rami gingivales inferiores,* fine branches, which go off in the canalis mandibulae; of the former there is one for each root of a tooth; the latter go to the alveoli and to the gum. They form a plexus, *plexus dentalis inferior,* above the n. mandibularis.

γ) *N. mentalis* (see Fig. 827), a large branch, leaves the canalis mandibulae by way of the foramen mentale, covered by the m. triangularis. It divides into *rami mentales*, which, perforating this muscle, go to the skin of the chin, and *rami labiales inferiores*, which pass upward to the skin and mucous membrane of the lower lip.

10. *N. lingualis* (see Figs. 827—829 and 834), almost as large as the n. alveolaris inferior, runs in front of the latter nerve and somewhat medianward from it, on the medial side of the m. pterygoideus externus and of the a. maxillaris interna, then between the m. pterygoideus internus and the ramus of the lower jaw, slightly curved, downward and forward, then passes under the m. mylopharyngeus and in front of the m. styloglossus (see Figs. 606, 628 and 834) on the lateral side of the latter, and, under the mucous membrane of the floor of the mouth, passes forward over the m. mylohyoideus and the glandula submaxillaris, goes around the ductus submaxillaris [Whartoni] lateral and below (see also Fig. 591) and then breaks up.

Upon the m. pterygoideus internus it unites with the chorda tympani (see p. 724), which approaches it at an acute angle from behind and above. This anastomosis with the n. facialis carries certainly: 1. to the n. lingualis the secretory fibres for the glandula submaxillaris und sublingualis, which arise from the n. intermedius, 2. from the n. lingualis the pure sensory fibres and the taste fibres from the anterior two-thirds of the tongue (see Fig. 836) to the n. facialis. From there on the sensory fibres pass through the n. petrosus superficialis major to the ganglion sphenopalatinum, to the n. maxillaris (V) and farther centralward. The farther path of the taste fibres is questionable: either they run from the n. facialis also through the n. petrosus superficialis major to the ganglion sphenopalatinum, thence to the n. maxillaris (V) and farther centralward, or through the ramus anastomoticus cum plexu tympanico to the n. petrosus superficialis minor, to the ganglion oticum, to the n. mandibularis (V) and farther centralward, or they arrive in the brain by way of the n. intermedius.

The n. lingualis is united farther by several threads with the ganglion submaxillare (vide infra) and anastomoses upon the lateral surface of the m. hyoglossus with the n. hypoglossus through one or two *rami anastomotici cum n. hypoglosso* (see Fig. 834), by means of which sensory fibres probably pass over into the peripheral part of the n. hypoglossus. Branches:

α) *Rami isthmi faucium* (see Fig. 834), fine, go between lower jaw and m. pterygoideus internus to the tonsil and to the posterior part of the mucous membrane of the mouth.

β) *N. sublingualis* (see Figs. 591 and 828) runs forward, lateral from the glandula sublingualis, innervates this gland (vide supra) and the neighboring mucous membrane.

γ) *Rami linguales* (see Figs. 828 and 834) pass through the musculature of the tongue to the mucous membrane of the back and of the margins of the anterior two-thirds of the tongue (see also above and Fig. 836). They anastomose manifoldly with the same branches of the other side and with those of the n. glossopharyngeus.

Ganglion oticum (see Fig. 829), is a sympathetic ganglion (see also p. 788), a grayish-red, flatly rounded body, which lies close under the foramen ovale, immediately adjacent to the medial surface of the n. mandibularis; medianward it lies close to the pars cartilaginea tubae auditivae; close behind it runs the a. meningea media. The so-called *roots* of the ganglion are:

α) Communicating threads with the n. mandibularis, usually two, very delicate, from the upper margin.

β) Communicating threads with the sympathetic plexus meningeus (see p. 788).

γ) Communicating threads through a special canal with the n. canalis pterygoidei [Vidii].

δ) *N. petrosus superficialis minor* (see Figs. 829 and 831) is in largest part a continuation of the n. tympanicus (IX) (see p. 730), but it also receives a thread of communication from the n. facialis (see p. 724) and anastomoses with the n. petrosus superficialis major; it runs through the upper part of the canaliculus tympanicus, goes through its apertura superior into the sulcus n. petrosi superficialis minoris and then passes either through the fissura shenopetrosa or through a special canaliculus, medianward, forward and downward to the ganglion. In it run secretory fibres for the glandula parotis (see p. 722: n. auriculotemporalis), as well as taste fibres perhaps (vide supra: n. lingualis).

So-called *branches* of the ganglion (see Fig. 829):

α) Threads to the nn. pterygoideus internus, tensoris tympani and tensoris veli palatini.

β) *Ramus anastomoticus cum n. spinoso*, fine thread to the n. spinosus.

γ) *Ramus anastomoticus cum n. auriculotemporali*, fine threads to the n. auriculotemporalis, in which the secretory fibres for the parotid gland run (see p. 722).

δ) *Ramus anastomoticus cum chorda tympani*, one or two fine threads to the chorda tympani.

Ganglion submaxillare (see Figs. 591 and 828) is a sympathetic ganglion (see also p. 788), a spindle-shaped body lying directly in front of the m. pterygoideus internus, under the n. lingualis and over the glandula submaxillaris. It communicates with the n. lingualis by means of several *rami communicantes cum n. linguali*, some of them pass upward and are attached to the n. lingualis in centripetal direction, others run forward to the peripheral part of the n. lingualis. It farther communicates by means of fine threads with the sympathetic *plexus maxillaris externus* surrounding the a. maxillaris externa. From the lower margin several threads, *rami submaxillares*, go to the glandula submaxillaris (see p. 723) and to the ductus submaxillaris [Whartoni].

VI. **N. abducens** (see Figs. 749, 750, 758, 817—822, 916, 919—921), motor, leaves the brain, on each side, at the lower, posterior margin of the pons in the groove between this and the pyramid, runs between the pons and the clivus upward, lateralward and forward (see Fig. 758) and perforates the dura mater medialward from and beneath the n. trigeminus, somewhat below the apex of the pyramid; it then passes over this into the sinus cavernosus, goes forward in the middle through it (see also Fig. 533), lateral from and below the a. carotis interna, medial from the n. ophthalmicus (V), enters the annulus tendineus communis [Zinni] under the nn. oculomotorius and nasociliaris (V) through the fissura orbitalis superior, becomes applied to the medial surface of the m. rectus lateralis and ends in it.

Anastomoses: In the sinus cavernosus it receives sympathetic fibres from the plexus cavernosus.

VII. **N. facialis** (see Figs. 749, 750, 758, 817—819, 824, 827—829, 831—833 and 837), motor, appears on each side lateral from the n. abducens, just medial from the nn. intermedius and acusticus, at the inferior, posterior margin of the brachium pontis (see p. 651) above and somewhat lateral from the olive; it passes lateralward along with the nn. intermedius and acusticus at the upper margin of the flocculus in front of the brachium pontis upon the tuberculum jugulare oss. occipitalis and upon the facies posterior pyramidis, and runs upward and forward to the porus acusticus internus (see Figs. 819 and 833) and into the meatus acusticus internus. In this the n. facialis lies over the n. acusticus in a groove of the latter, the n. intermedius between the two; they have a sheath in common formed by continuations of the meninges, and of the cavum subdurale and subarachnoideale, all of which reach as far as the bottom of the meatus. From there on it runs lateralward with the n. intermedius (vide infra) in the canalis facialis (see Figs. 829 and 831) to the geniculum canalis facialis, there bends sharply around, *geniculum n. facialis (facial knee)*, and extends further, first backward and lateralward and then downward. At the foramen stylomastoideum it leaves the canalis facialis, enters the substance of the parotid gland and within it runs in an arch concave upward and medianward (see Figs. 827—829), in front of the posterior belly of the m. digastricus and laterally from the proc. styloideus, a. carotis externa and v. facialis posterior upon the lateral surface of the ramus of the lower jaw, there to break up into its terminal branches (see Fig. 832). It innervates the whole mimic musculature of the face.

N. intermedius (see Figs. 749 and 758), a mixed nerve, leaves the brain just lateral from the n. facialis, between it and the n. acusticus (n. vestibularis), enters the canalis facialis with the n. facialis (vide supra), and is at first loosely and then more intimately united with the n. facialis. Its sensory part forms at the geniculum n. facialis the *ganglion geniculi* (see Fig. 831), a conical aggregation of ganglion cells comparable to those of the spinal ganglia, with its apex directed medianward and intimately united with the n. facialis; the ganglion geniculi anastomoses with the ganglion vestibulare by a delicate nerve-thread. The farther course of the fibres is only partly known; the secretory fibres in it coming from the brain for the glandulae submaxillaris and sublingualis go over into the chorda tympani (vide infra); the latter is often looked upon as the direct continuation of the n. intermedius; the fibres for the lachrymal gland, all of which are carried by it, enter into the n. petrosus superficialis major (see also p. 714).

A. Branches of the n. facialis (and partly of the n. intermedius) within the temporal bone:

1. *N. petrosus superficialis major* from the geniculum n. facialis to the ganglion sphenopalatinum (see p. 717).

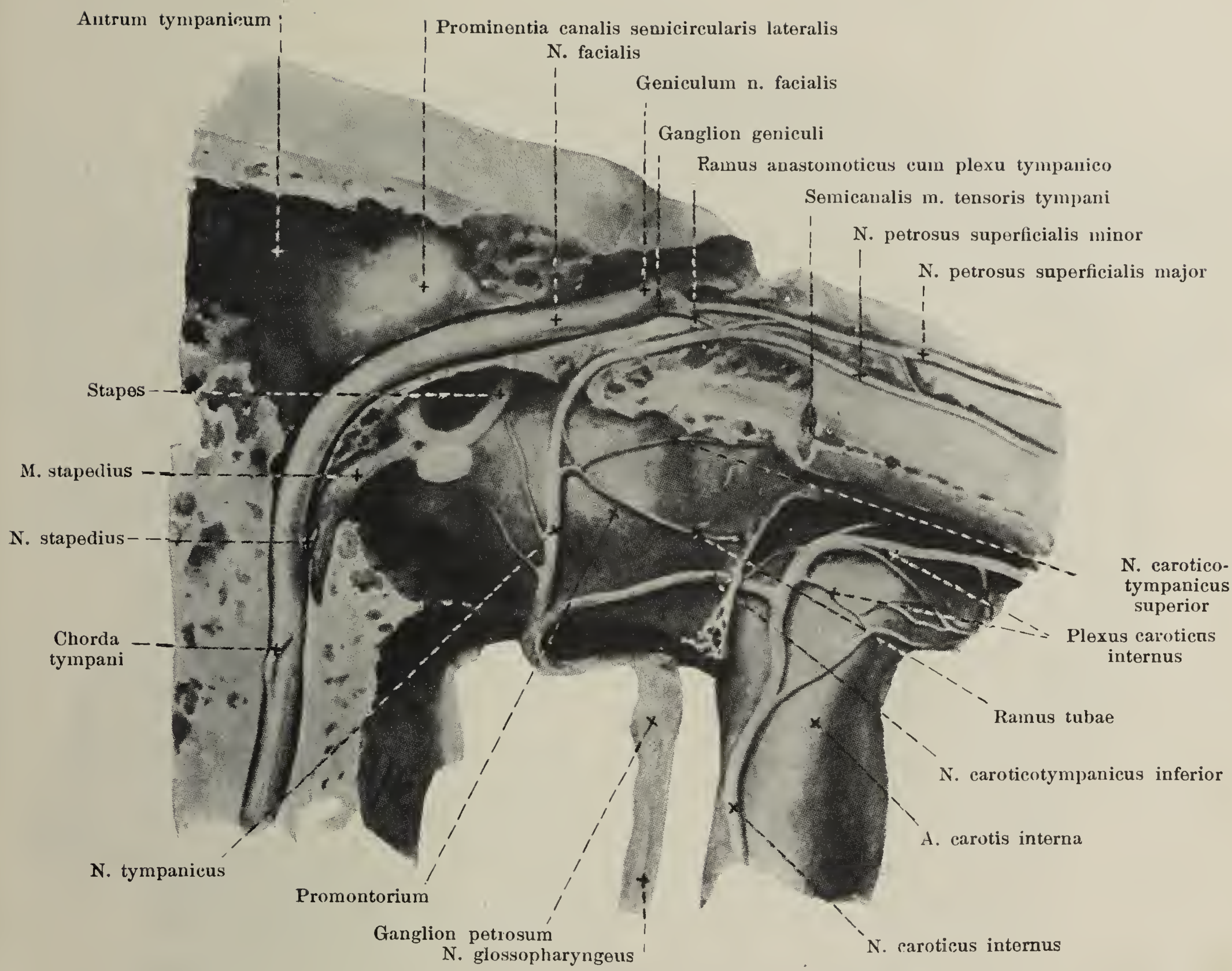
2. *Ramus anastomoticus cum plexu tympanico* (see Fig. 831), a fine thread, from the geniculum n. facialis to the n. petrosus superficialis minor (see p. 723).

3. *N. stapedius* (see Fig. 831) arises in the vertical part of the canalis facialis and passes through a small opening to the m. stapedius, situated within the eminentia pyramidalis.

4. *Chorda tympani* (see Figs. 828, 829, 831, 834, 945, 947 and 948) goes off beneath the preceding, running back in an acute angle open above; it runs at first through the canaliculus chordae tympani to the cavum tympani, then in the plicae malleolares posterior and anterior between the crus longum incudis and manubrium mallei, and finally in the fissura petrotympanica [Glaseri], in order to pass medial from the spina angularis, a. meningea media, and the nn. auriculotemporalis and alveolaris inferior downward to the posterior margin of the n. lingualis (see p. 723). In its course it describes a curve, convex upward and lateralward, and is connected by one or two fine threads with the ganglion oticum (see p. 723). Concerning its fibres see n. lingualis, p. 723.

B. Branches of the n. facialis outside the skull:

1. *N. auricularis posterior* (see Figs. 832, 837 and 845) arises close under the foramen stylomastoideum, runs upward and backward on the anterior surface of the processus mastoideus, between this and the external ear, near the a. auricularis posterior, anastomoses by fine threads with the sensory nn. occipitalis minor (C_2 C_3) and auricularis magnus (C_3), and sends an anterior branch upward to the mm. auriculares posterior and superior, as well as to the mm. transversus auriculae, obliquus auriculae and antitragicus, and a posterior branch horizontally, *ramus occipitalis*, to the m. occipitalis.


Antrum tympanicum
Prominentia canalis semicircularis lateralis
N. facialis
Geniculum n. facialis
Ganglion geniculi
Ramus anastomoticus cum plexu tympanico
Semicanalis m. tensoris tympani
N. petrosus superficialis minor
N. petrosus superficialis major
Stapes
M. stapedius
N. stapedius
Chorda tympani
N. caroticotympanicus superior
Plexus caroticus internus
Ramus tubae
N. caroticotympanicus inferior
A. carotis interna
N. tympanicus
Promontorium
Ganglion petrosum
N. glossopharyngeus
N. caroticus internus

831. Right n. facialis and plexus tympanicus,
viewed from in front. Magnification: 4 : 1.
(The canalis facialis, canaliculus tympanicus and canalis caroticus have been opened.)

2. ***Ramus digastricus*** (see Figs. 828 and 837) arises close under the preceding and passes downward to the anterior surface of the venter posterior m. digastrici, which it innervates. Branches:

α) ***Ramus stylohyoideus,*** a long thread, downward and forward to the m. stylohyoideus.

β) ***Ramus anastomoticus cum n. glossopharyngeo*** (see Fig. 837) given off in the m. digastricus or previously, runs medianward in a curve, convex below, to the n. glossopharyngeus, which it reaches below the ganglion petrosum.

C. Terminal branches of the n. facialis (see Figs. 832 and 845), an upper, usually the larger, and a lower; the two usually form an obtuse angle with one another. The upper one passes upward and forward, the lower one to the angulus mandibulae. Their branches form a plexus, *plexus parotideus* (see Fig. 832), often distinct only above. The upper branch communicates by two threads with the n. auriculotemporalis (see p. 722). The terminal branches are subdivisible into:

1. ***Rami temporales,*** over the zygomatic arch, upward to the mm. helicis major, helicis minor, tragicus, mm. auriculares superior and anterior, as well as upward and forward to the mm. frontalis, orbicularis oculi and corrugator.

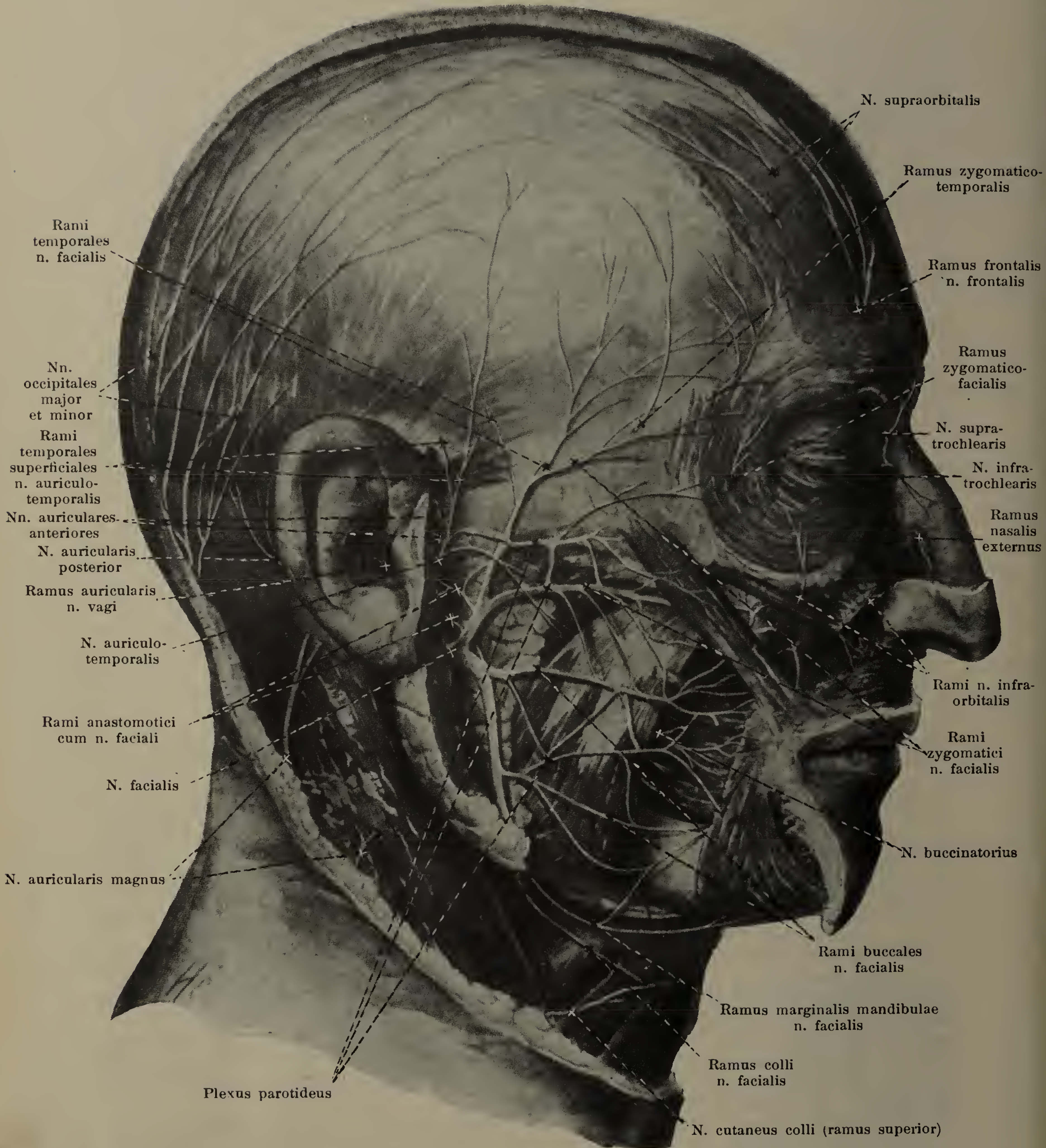
2. ***Rami zygomatici*** forward to the mm. orbicularis oculi and zygomaticus.

3. ***Rami buccales,*** upon the m. masseter, forward to the mm. risorius, zygomaticus, quadratus labii superioris, procerus, caninus, buccinator, incisivi, orbicularis oris, triangularis, quadratus labii inferioris and to the muscles of the nose.

4. ***Ramus marginalis mandibulae*** runs along the base of the lower jaw to the region of the chin and gives branches to the mm. quadratus labii inferioris and mentalis.

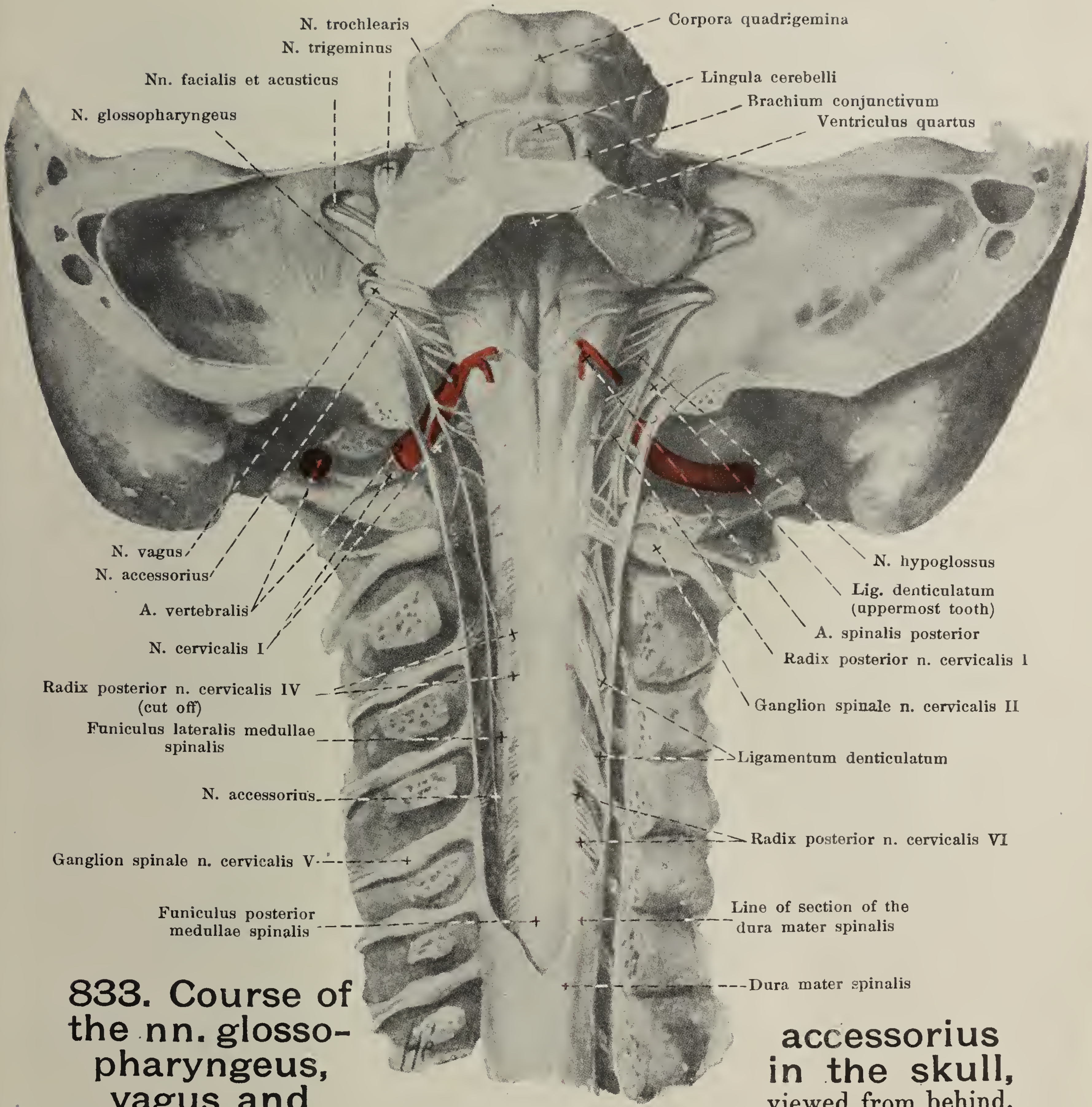
5. ***Ramus colli*** from the angle of the lower jaw on the neck forward and downward, covered by the platysma, which it alone innervates. It anastomoses with the (sensory) n. cutaneus colli (C_2, C_3).

These branches form numerous anastomoses with branches of the n. trigeminus, especially the rami temporales with the n. supraorbitalis and the rami buccales with the n. buccinatorius.


N. supraorbitalis
Ramus zygomatico-temporalis
Ramus frontalis n. frontalis
Ramus zygomatico-facialis
N. supratrochlearis
N. infratrochlearis
Ramus nasalis externus
Rami n. infraorbitalis
Rami zygomatici n. facialis
N. buccinatorius
Rami buccales n. facialis
Ramus marginalis mandibulae n. facialis
Ramus colli n. facialis
N. cutaneus colli (ramus superior)
Rami temporales n. facialis
Nn. occipitales major et minor
Rami temporales superficiales n. auriculotemporalis
Nn. auriculares anteriores
N. auricularis posterior
Ramus auricularis n. vagi
N. auriculotemporalis
Rami anastomotici cum n. faciali
N. facialis
N. auricularis magnus
Plexus parotideus

832. Nerves of the face, viewed from the right.

(The platysma has been removed: a piece has been cut out of the glandula parotis.)


N. trochlearis
N. trigeminus
Nn. facialis et acusticus
N. glossopharyngeus
Corpora quadrigemina
Lingula cerebelli
Brachium conjunctivum
Ventriculus quartus
N. vagus
N. accessorius
A. vertebralis
N. cervicalis I
Radix posterior n. cervicalis IV (cut off)
Funiculus lateralis medullae spinalis
N. accessorius
Ganglion spinale n. cervicalis V
Funiculus posterior medullae spinalis
N. hypoglossus
Lig. denticulatum (uppermost tooth)
A. spinalis posterior
Radix posterior n. cervicalis I
Ganglion spinale n. cervicalis II
Ligamentum denticulatum
Radix posterior n. cervicalis VI
Line of section of the dura mater spinalis
Dura mater spinalis

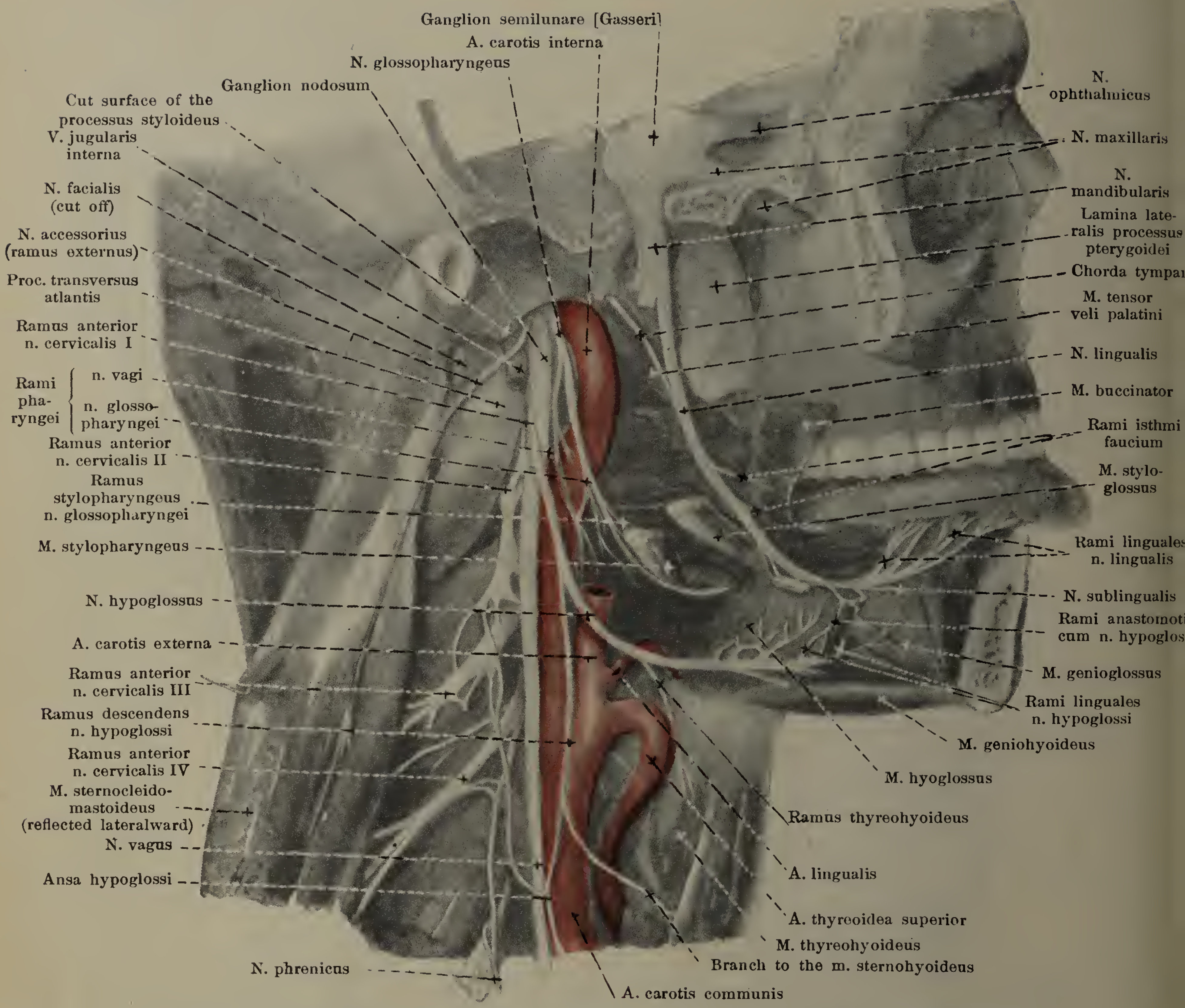
833. Course of the nn. glossopharyngeus, vagus and accessorius in the skull, viewed from behind.

(The occipital bone and the vertebral arches have been largely sawn away, the cerebrum and cerebellum cut away; the sac of the dura mater spinalis has been opened. On the left the posterior roots of the cervical nerves have been partly removed, the lig. denticulatum completely.)

VIII. **N. acusticus,** *acoustic nerve* (see also Figs. 749, 750, 755, 758, 817—819, 972 and 973), is a sensory nerve, which appears on each side with two roots at the lower posterior margin of the brachium pontis above and behind the olive. The medial root *(radix n. vestibularis)* appears just lateral from the n. intermedius in front of the corpus restiforme, the lateral *(radix n. cochlearis)* passes around the latter like an arch from the outside. The n. acusticus passes with the nn. facialis and intermedius into the meatus acusticus internus (see p. 724) and there divides into two branches, the *n. vestibularis* and the *n. cochlearis.*

1. The *n. vestibularis* (s. Figs. 972 and 973) is interrupted at the bottom of the internal acoustic meatus by a ganglion, *ganglion vestibulare* (which anastomoses by a thread with the ganglion geniculi [see p. 724]), and divides into an upper and a lower terminal branch. The former goes from the area vestibularis superior to the macula cribrosa superior vestibuli; its branches run as follows:

α) *N. utricularis* to the macula acustica utriculi,
β) *N. ampullaris superior* to the ampulla membranacea superior and
γ) *N. ampullaris lateralis* to the ampulla membranacea lateralis.


Ganglion semilunare [Gasseri]
A. carotis interna
N. glossopharyngeus
Ganglion nodosum
Cut surface of the processus styloideus
V. jugularis interna
N. facialis (cut off)
N. accessorius (ramus externus)
Proc. transversus atlantis
Ramus anterior n. cervicalis I
Rami pharyngei n. vagi
n. glossopharyngei
Ramus anterior n. cervicalis II
Ramus stylopharyngeus n. glossopharyngei
M. stylopharyngeus
N. hypoglossus
A. carotis externa
Ramus anterior n. cervicalis III
Ramus descendens n. hypoglossi
Ramus anterior n. cervicalis IV
M. sternocleidomastoideus (reflected lateralward)
N. vagus
Ansa hypoglossi
N. phrenicus
N. ophthalmicus
N. maxillaris
N. mandibularis
Lamina lateralis processus pterygoidei
Chorda tympai
M. tensor veli palatini
N. lingualis
M. buccinator
Rami isthmi faucium
M. styloglossus
Rami linguales n. lingualis
N. sublingualis
Rami anastomoti cum n. hypoglos
M. genioglossus
Rami linguales n. hypoglossi
M. geniohyoideus
M. hyoglossus
Ramus thyreohyoideus
A. lingualis
A. thyreoidea superior
M. thyreohyoideus
Branch to the m. sternohyoideus
A. carotis communis

834. Nerves to the right side of the tongue,
viewed from the right.

(The right half to the lower jaw with its muscles and the processus styloideus with its muscles have been removed; the foramen ovale has been exposed from the lateral side.)

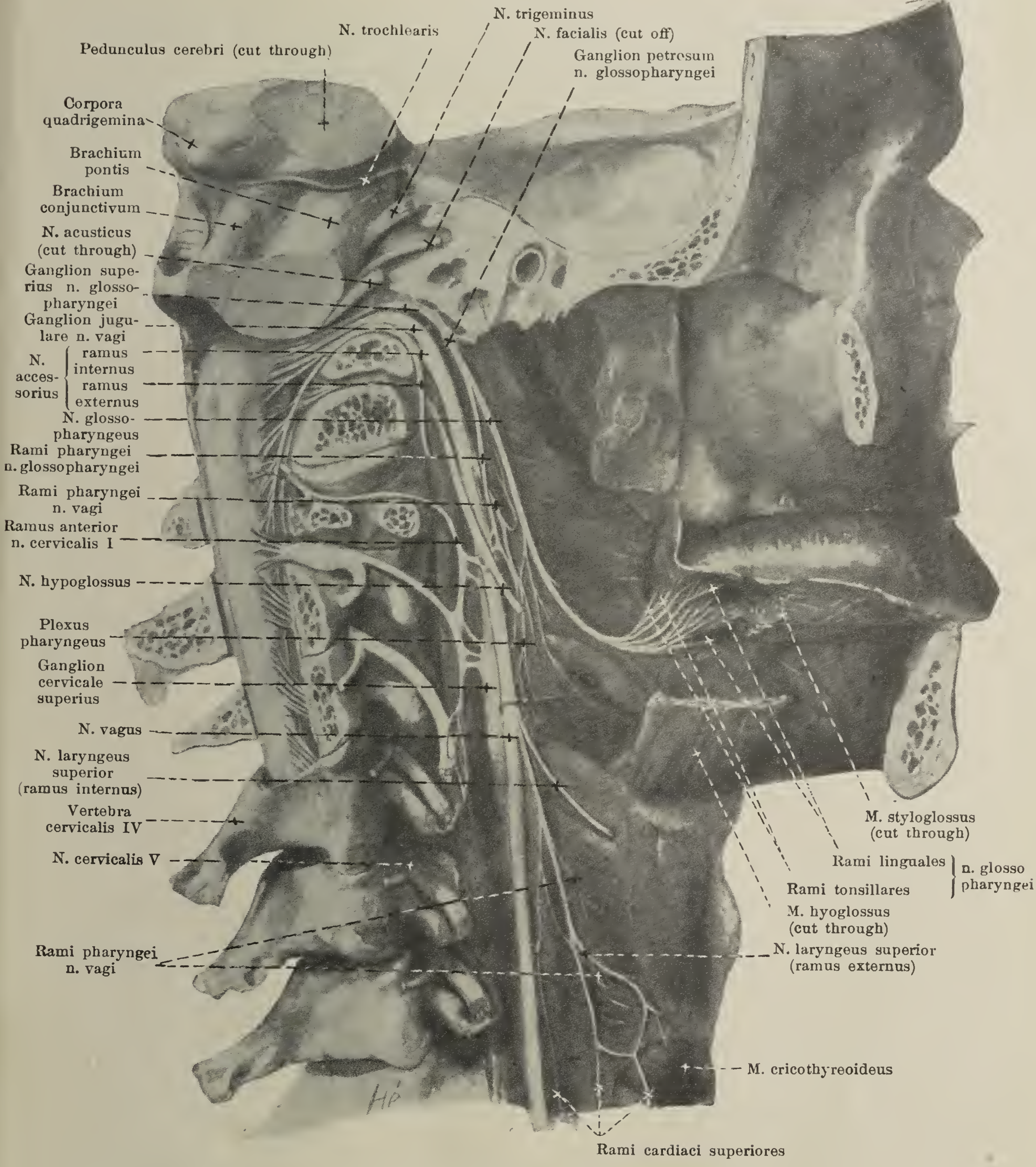
1. *N. vestibularis* (continued) (see Figs. 972 and 973). Its lower terminal branch divides into:

δ) *N. saccularis*, which passes out from the area vestibularis inferior through the macula cribrosa media vestibuli to the macula acustica sacculi, and

ε) *N. ampullaris posterior*, which passes from the foramen singulare through the macula cribrosa inferior vestibuli to the ampulla membranacea posterior.

2. *N. cochlearis* goes through the tractus spiralis foraminosus into the canales longitudinales modioli and in the canalis spiralis modioli forms the long stretched-out *ganglion spirale.*

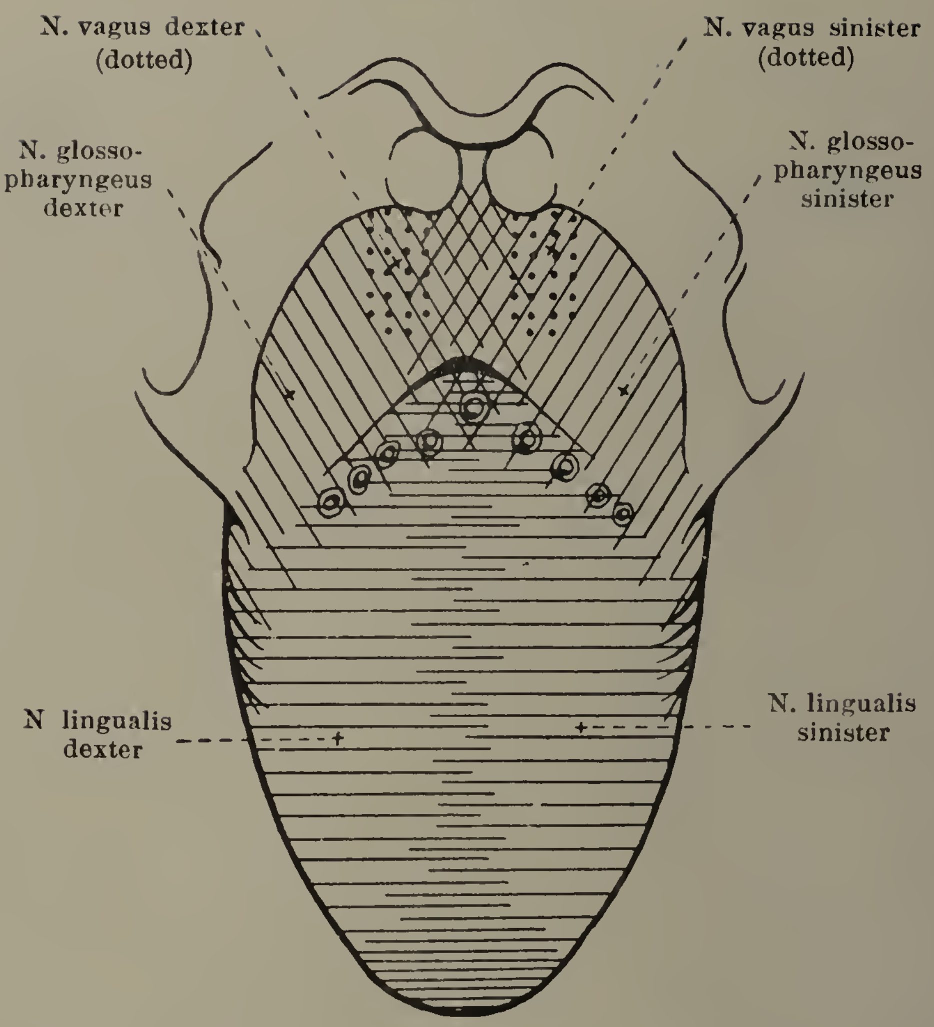
IX. **N. glossopharyngeus** (see also Figs. 749, 750, 755, 758, 817, 819, 831, 833, 835 and 837), a mixed nerve, appears with 5—6 threads below the n. acusticus in the upper part of a groove of the medulla oblongata running behind the olive (see p. 649); upon the tuberculum jugulare under the flocculus it passes almost horizontally lateralward and forward to the foramen jugulare; it runs through the most anterior, medial part of the latter, separated from the n. vagus and n. accessorius by a strip of dura mater (see Figs. 817, 819 and 835), passing in a curve downward and forward. In the foramen jugulare it becomes swollen to form the small *ganglion superius* and beneath this in the fossula petrosa to form the somewhat larger, elongated *ganglion petrosum* (see Figs. 831 and 835).


N. trigeminus
N. trochlearis
N. facialis (cut off)
Pedunculus cerebri (cut through)
Ganglion petrosum n. glossopharyngei
Corpora quadrigemina
Brachium pontis
Brachium conjunctivum
N. acusticus (cut through)
Ganglion superius n. glossopharyngei
Ganglion jugulare n. vagi
N. accessorius ramus internus
ramus externus
N. glossopharyngeus
Rami pharyngei n. glossopharyngei
Rami pharyngei n. vagi
Ramus anterior n. cervicalis I
N. hypoglossus
Plexus pharyngeus
Ganglion cervicale superius
N. vagus
N. laryngeus superior (ramus internus)
Vertebra cervicalis IV
N. cervicalis V
Rami pharyngei n. vagi
M. styloglossus (cut through)
Rami linguales
Rami tonsillares
n. glossopharyngei
M. hyoglossus (cut through)
N. laryngeus superior (ramus externus)
M. cricothyreoideus
Rami cardiaci superiores

835. Right nerves of the pharynx, viewed from the right and somewhat from behind. (The preparation is similar to that of Fig. 834; in addition the medulla oblongata and the course of the nerves in the bone have been exposed; the muscles of the spine have been completely removed, those of the tongue partly.)

IV. **N. glossopharyngeus** (continued). The two ganglia may fuse with one another; they are similar in construction to the spinal ganglia and contain the cells of origin of the sensory fibres of the nerve (see p. 700); the motor fibres run past these ganglion cells.

Outside the skull the nerve goes downward, at first behind, then lateral from, the a. carotis interna, between it and the m. stylopharyngeus and then bends around the posterior margin of the latter upon its lateral surface (see also Fig. 834).


N. vagus dexter (dotted)
N. vagus sinister (dotted)
N. glosso-pharyngeus dexter
N. glosso-pharyngeus sinister
N lingualis dexter
N. lingualis sinister

836. Distribution of sensory nerves in the mucous membrane of the tongue, schematic (after R. Zander).

IX. **N. glossopharyngeus** (see Figs. 834 and 835) (continued). It then passes in a curve, convex downward and backward, on the medial side of the m. styloglossus to the root of the tongue. Branches: A) From the ganglion petrosum:

1. ***N. tympanicus*** (see Fig. 831) runs upward in the canaliculus tympanicus (see p. 14) first into the cavity of the tympanum, then in the sulcus promontorii, becomes directly continuous in the upper part of the canaliculus tympanicus with the n. petrosus superficialis minor (see p. 723) and communicates by a fine thread with the n. facialis (see p. 724). In the lowermost part it is surrounded by a swelling of vascular tissue, the ***intumescentia tympanica.*** Upon the promontorium it forms with its branches the ***plexus tympanicus [Jacobsoni].*** In it run the secretory fibres to the glandula parotis (see p. 722). Branches:

α) ***Ramus tubae***, delicate, runs forward to the mucous membrane of the ear trumpet; besides it sends delicate branches backward to the region of the fenestra vestibuli and fenestra cochleae.

β) ***N. caroticotympanicus superior***, delicate, runs medianward in the cavum tympani and through a special canal to the sympathetic plexus caroticus internus surrounding the a. carotis interna, sometimes also to the n. petrosus superficialis major.

γ) ***N. caroticotympanicus inferior*** connects the plexus tympanicus [Jacobsoni] with the plexus caroticus internus; at the same time it passes through one or two canaliculi caroticotympanici and runs upon or under the promontorium.

2. ***Ramus anastomoticus cum ramo auricülari n. vagi*** (see Fig. 837), a delicate thread to the ramus auricularis n. vagi; it may be absent. Besides, a delicate thread goes from the ganglion petrosum to the vagus, just below the ganglion jugulare (see p. 733).

3. A communicating thead with the ganglion cervicale superius (branch of the n. jugularis).

4. A branch to the ramus digastricus n. facialis (see p. 725).

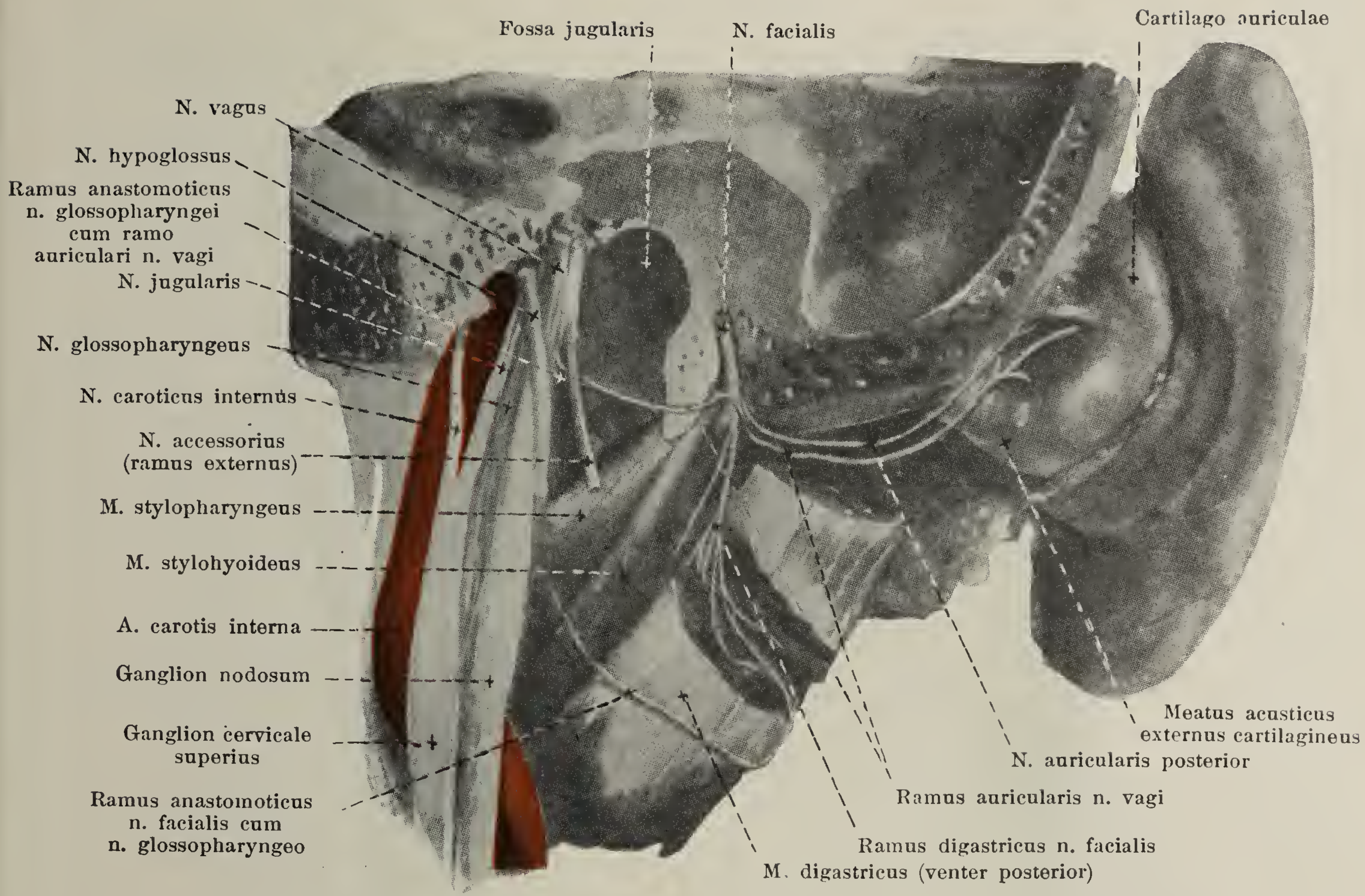
B. Peripheral branches:

5. ***Rami pharyngei*** (see Figs. 834 and 835), 2 or 3, go off at variable levels on the lateral surface of the a. carotis interna and help to form the plexus pharyngeus (see p. 733).

6. ***Ramus stylopharyngeus*** (see Fig. 834) goes off behind the m. stylopharyngeus and passes to this muscle (these fibres are said not to be motor, see p. 733: rami pharyngei n. vagi).

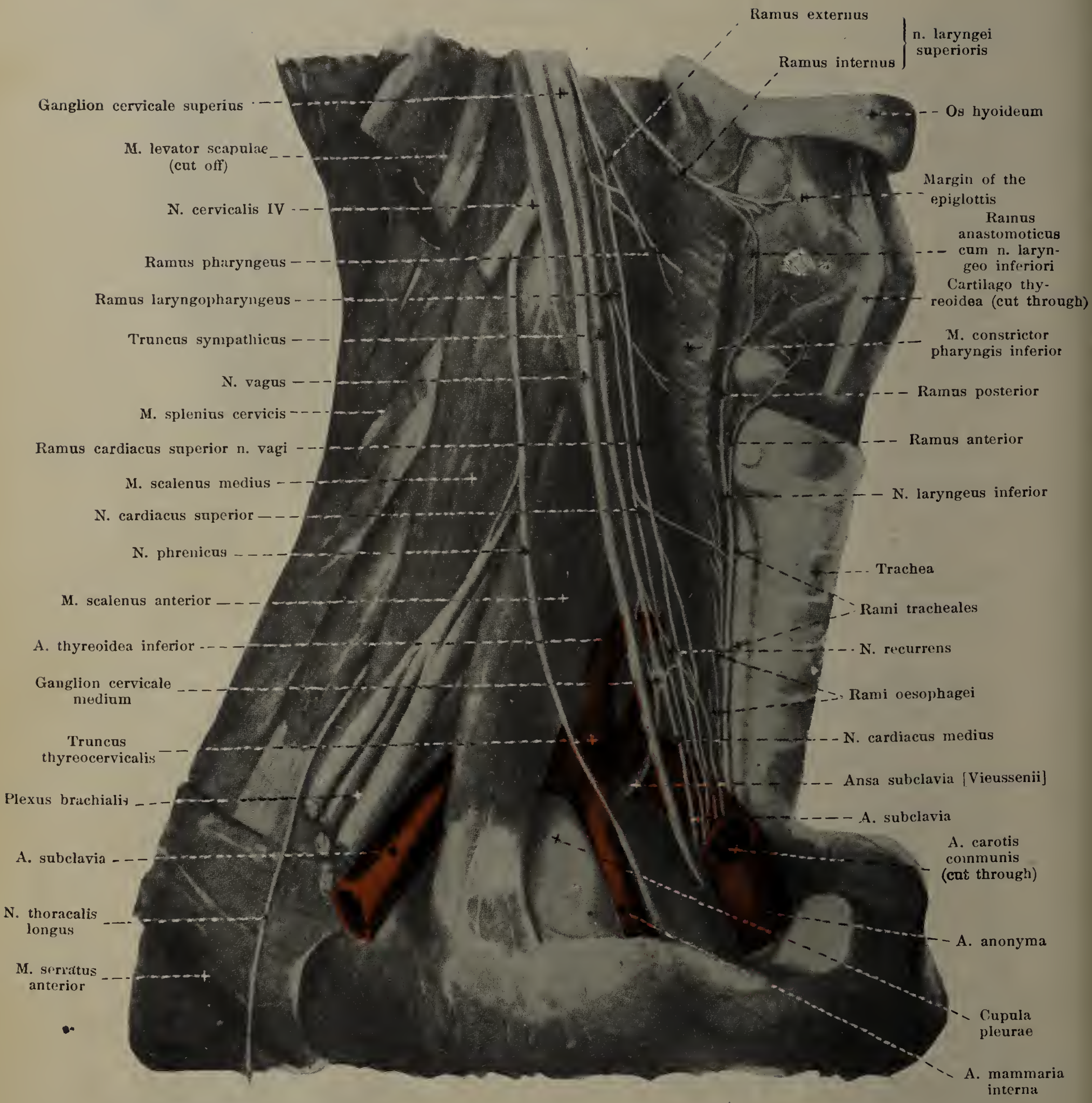
7. ***Rami tonsillares*** (see Fig. 835) arise close behind the root of the tongue and pass to the mucous membrane of the tonsil and of the palatine arch.

8. ***Rami linguales*** (see Fig. 835) to the mucous membrane of the posterior third of the tongue (see Fig. 836); they unite manifoldly with one another, and carry chiefly the taste fibres and other sensory fibres for this region. Numerous anastomoses exist between the right and left branches and those of the nn. linguales (V).


Fossa jugularis
N. facialis
Cartilago auriculae
N. vagus
N. hypoglossus
Ramus anastomoticus n. glossopharyngei cum ramo auriculari n. vagi
N. jugularis
N. glossopharyngeus
N. caroticus internus
N. accessorius (ramus externus)
M. stylopharyngeus
M. stylohyoideus
A. carotis interna
Ganglion nodosum
Ganglion cervicale superius
Ramus anastomoticus n. facialis cum n. glossopharyngeo
Meatus acusticus externus cartilagineus
N. auricularis posterior
Ramus auricularis n. vagi
Ramus digastricus n. facialis
M. digastricus (venter posterior)

837. Right ramus auricularis n. vagi, viewed from behind.
(The head has been removed from the spine by a frontal section; the processus mastoideus with the origin of the m. digastricus has been subsequently removed.)

X. **N. vagus** (see Figs. 749, 750, 755, 758, 817, 819 and 833—839), a mixed nerve, leaves the brain with 10—15 fila radicularia just below the n. glossopharyngeus in a sulcus of the medulla oblongata running behind the olive (see p. 649). The fibres converge to form a round nerve stem which passes lateralward in front of the tonsilla cerebelli on the tuberculum jugulare to the anterior compartment of the foramen jugulare, and downward through this in a curve (see Figs. 817, 819, 833 and 835). It together with the n. accessorius is accompanied there by a process of the dura mater and arachnoidea and is separated by these from the n. glossopharyngeus. In the foramen jugulare it presents a small swelling, *ganglion jugulare* (see Fig. 835); below it receives the ramus internus n. accessorii (see p. 734), and becomes thickened, its bundles loosening up plexus-like, to form the elongated spindle-shaped *ganglion nodosum* (see also Figs. 834 and 835). Both ganglia are in the main similar in structure to the spinal ganglia and contain the cells of origin of the sensory fibres of the nerve (see p. 700); the motor fibres run past the ganglion cells. Just beneath the foramen jugulare (see also Figs. 834 and 835) the n. vagus lies behind the n. glossopharyngeus, in front of the n. accessorius and the v. jugularis interna and lateral from the n. hypoglossus, which then loops around past the posterior surface of the ganglion nodosum to the lateral side of the n. vagus. The n. vagus then lies in the groove between the a. carotis interna or communis and v. jugularis interna (see also Fig. 358) and passes with these vessels down the neck (see Figs. 834, 835 and 838) as far as the upper aperture of the thorax; in its course it lies somewhat lateralward and in front of the ganglion cervicale superius and the truncus sympathicus. From there on downward the right and left nerve behaves somewhat differently. On the right side (see Figs. 838 and 846) the nerve runs in front of the a. subclavia (medial from the truncus thyreocervicalis) and downward behind the v. subclavia and gives off here the n. recurrens which loops around the inferior surface of the a. subclavia in a curve backward and upward. The nerve then passes downward and backward (see Figs. 680 and 682) on the right side of the trachea to the posterior surface of the bronchus dexter (in front of the v. azygos) and there breaks up into an elongated plexus. From this one or several strands run on the posterior surface of the oesophagus, anastomose with one another there *(plexus oesophageus posterior)* and exchange fibres with the left n. vagus so that after its passage through the diaphragm the right nerve is always a least twice as thick as the left nerve.



838. Right n. vagus in the neck, viewed from the right.

(The scapula and clavicle with their muscles, the hyoid muscles and the thyroid gland have been completely removed; the large vessels have been partially removed.)

X. **N. vagus** (continued): The left n. vagus (see Figs. 681—683, 839 and 846) descends between the aa. carotis communis and subclavia sinistra, directly in contact with the pleura mediastinalis to the anterior, left surface of the arcus aortae and there sends off the n. recurrens, which runs upward and backward in a curve around the inferior surface of the arcus aortae. The further course of the n. vagus differs from that of the right side only through the fact that it lies upon the anterior surface of the oesophagus (there forming with branches of the right n. vagus the *plexus oesophageus anterior);* on its farther communication with the right n. vagus see also p. 731.

Branches from A) Cephalic part of the n. vagus (between brain and ganglion nodosum):

1. *Ramus meningeus* (not illustrated), from the ganglion jugulare, upward and recurrent through the foramen jugulare, gives off branches to the dura mater around the latter.

2. Anastomosis with the ganglion cervicale superius (branch of the n. jugularis).

3. *Ramus auricularis* (see Fig. 837) arises close below the ganglion jugulare, but usually receives a thread from the n. glossopharyngeus (see p. 730), passes in front of the n. accessorius and the bulbus v. jugularis superior in the fossa jugularis to the canaliculus mastoideus and through this to the canalis facialis, and lies in contact with the n. facialis as far as the foramen stylomastoideum, it then runs upward in a curve at the anterior margin of the processus mastoideus near the n. auricularis posterior, perforates the membranous part of the auricula and is distributed to the concave surface of the auricula (see Fig. 832) and to the external acoustic meatus.

4. *Ramus anastomoticus cum n. glossopharyngeo* (see Fig. 835, not designated), 1—2 fine threads of communication between the ganglion petrosum n. glossopharyngei and the n. vagus.

5. Communication of the n. vagus with the ramus internus n. accessorii (see p. 731 and 734).

B) Cervical part of the n. vagus (as far as the origin of the n. recurrens):

1. Anastomoses between the ganglion nodosum and α) the ganglion cervicale superius (see Fig. 837) and β) the n. hypoglossus (see Figs. 834 and 835).

2. *Rami pharyngei* (see Figs. 834 and 835), usually two, from the ganglion nodosum, between the a. carotis interna and externa, downward and forward to the pharynx, interweaving upon the m. constrictor pharyngis medius with the rami pharyngei n. glossopharyngei (see p. 730) and the rami laryngopharyngei of the sympathicus to form the *plexus pharyngeus.* From this arise the motor fibres for the mm. constrictores pharyngis, levator veli palatini, uvulae, glossopalatinus, pharyngopalatinus, which leave the brain in the n. vagus, and for the m. stylopharyngeus, which come from the brain in the n. glossopharyngeus and go into the n. vagus (vide supra) in the foramen jugulare, as well as the sensory fibres for the mucous membrane of the pharynx and of a part of the root of the tongue (see Fig. 836.

3. *N. laryngeus superior* (see Figs. 835 and 838), from the inferior extremity of the ganglion nodosum, runs downward and forward upon the m. constrictor pharyngis medius on the medial side of the a. carotis interna and externa; in its course it anastomoses by delicate threads with the plexus pharyngeus and the ganglion cervicale superius and gives off a delicate branch to the a. carotis interna. At the cornu superius oss. hyoidei it divides into two branches:

a) *Ramus externus* (see Figs. 835 and 838), the smaller of the two, descends almost vertically upon the external surface of the m. constrictor pharyngis inferior to the m. cricothyreoideus, supplies this with motor fibres and gives sensory fibres to the mucous membrane of the larynx. It receives a thread from the ganglion cervicale superius, anastomoses with the plexus pharyngeus and gives off *rami pharyngei* to the m. constrictor pharyngis inferior, often also a ramus cardiacus superior (vide infra).

b) *Ramus internus* (see Figs. 835 and 838) runs forward and downward medial from the a. thyreoidea superior and from the m. thyreohyoideus on the membrana hyothyreoidea (see also Fig. 834), perforates the latter along with the a. laryngea superior (see also Fig. 660), extends medianward and downward in the plica nervi laryngei (see Figs. 600 and 602) and divides into several branches (see Fig. 838). Some of these go upward near the epiglottis to its mucous membrane and to that of a small part of the root of the tongue (see also Fig. 836), others supply the mucous membrane of the larynx above the glottis and the pharyngeal mucous membrane behind the cartilagines arytaenoideae and cricoidea; a delicate twig, *ramus anastomoticus cum n. laryngeo inferiori,* passes downward upon the internal muscles of the larynx to the n. laryngeus inferior.

4. *Rami cardiaci superiores* (see Figs. 835, 838, 839 and 846), 1—3, arise at a variable height between the n. laryngeus superior and n. recurrens, the uppermost often wholly or partly from the n. laryngeus superior; they pass along the a. carotis communis (and, on the right side, the a. anonyma) to the aorta and there help to form the plexus cardiacus (see p. 791). They anastomose even in the neck with the nn. cardiaci of the sympathicus.

5. *N. recurrens* (see Figs. 685, 838, 839 and 846) (for origin see pp. 731 and 732) bends medianward and upward on the right around the inferior surface of the a. subclavia, on the left around that of the arcus aortae (lateral from the lig. arteriosum), passes from there, close to the trachea, vertically upward, on the right side on the right margin of the oesophagus, on the left side on its anterior surface, and ends above as the *n. laryngeus inferior.* It anastomoses with the ganglion cervicale inferius and the n. cardiacus superior. Branches:

a) *Rami cardiaci inferiores* (see Figs. 839 and 846), variable in number, arise partly from the thoracic part of the n. vagus and pass on the right side close to the a. anonyma, on the left side on the arcus aortae to the plexus cardiacus (see p. 791), which they help to form.

b) *Rami tracheales* (see Fig. 838) (some also from thoracic part of the n. vagus) to the musculature and mucous membrane of the trachea.

c) *Rami oesophagei* (see Fig. 838) to the wall of the oesophagus and of the pharynx.

d) *N. laryngeus inferior* (see Fig. 838) ascends usually between, more rarely behind or in front of the terminal branches of the a. thyreoidea inferior, on the medial surface of the lateral lobe of the thyroid gland, passes under the m. cricopharyngeus (see also Figs. 606 and 685) on its medial side and divides behind the articulatio cricothyreoidea into two branches.

The *ramus anterior* passes upward and forward upon the mm. cricoarytaenoideus lateralis and thyreoarytaenoideus and supplies these, as well as the mm. vocalis, arytaenoideus obliquus, aryepiglotticus and thyreoepiglotticus; the *ramus posterior* runs upward to the mm. cricoarytaenoideus posterior and arytaenoideus transversus, supplies them and anastomoses with the ramus internus n. laryngei superioris (see p. 733).

C) Thoracic part of the n. vagus (downward as far as the hiatus oesophageus):

1. Numerous anastomoses with the branches of the sympathicus.

2. *Rami bronchiales anteriores* (see Fig. 839) go over and under the bronchus to its anterior wall on it, with branches of the sympathicus, form a plexus, *plexus pulmonalis anterior*, which penetrates with the bronchus into the lung.

3. *Rami bronchiales posteriores* (see Fig. 839), larger and more numerous, form with branches of the sympathicus a narrow-meshed plexus upon the posterior surface of the bronchus, *plexus pulmonalis posterior*, which is manifoldly connected which that of the other side behind the bifurcatio tracheae; it passes forward with the bronchus into the lung.

4. *Rami oesophagei* (see Fig. 839) from the plexus oesophagei to the oesophagus.

5. *Rami pericardiaci* (not illustrated), several delicate branches from the stem of the n. vagus or from the plexus pulmonales and oesophagei to the surfaces of the pericardium.

D) Abdominal part of the n. vagus:

The left n. vagus (see Fig. 839) sends several diverging branches, *rami gastrici*, to the anterior wall of the stomach which anastomose with one another and with sympathetic nerves, and also along the curvatura minor small branches, *rami hepatici*, to the liver.

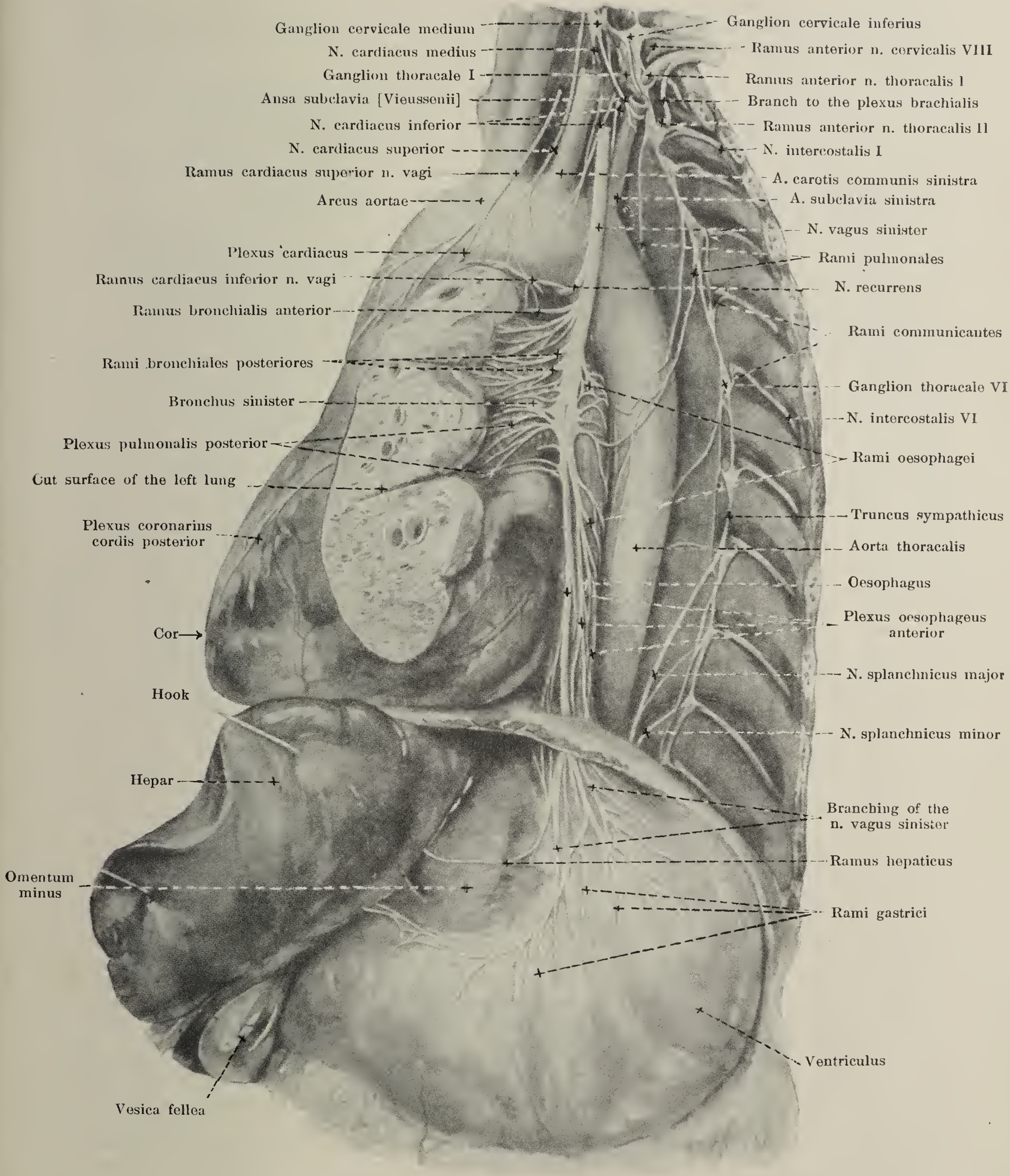
The right n. vagus (see Fig. 891) gives in a similar way branches, *rami gastrici*, to the posterior wall of the stomach; with the majority of its fibres *(rami coeliaci)* it passes near the a. gastrica sinistra to the ganglia coeliaca, then comes to lie close to the a. mesenterica superior and reaches along with the branches of this artery the entire small intestine (not large intestine). Besides these it sends small branches to the spleen *(rami lienales)*, to the pancreas, to the kidneys *(rami renales)* and suprarenals. The nerve anastomoses everywhere freely with sympathetic plexuses.

XI. **N. accessorius** (see Figs. 749, 750, 755, 758, 817, 819, 833—835, 837 and 845), motor, leaves the central organ by two kinds of root threads, superior and inferior. The 3—6 superior threads appear just below the n. vagus in a sulcus of the medulla oblongata running behind the olive (see p. 649), the inferior, added thereto, come from the funiculus lateralis of the cervical cord, usually down as far as the exit of the 5th, more rarely of the 7th cervical nerve, so that usually there is a root thread corresponding to each segment (see Figs. 833 and 835). The inferior threads unite to form a small stem which ascends between the posterior roots of the cervical nerves and the lig. denticulatum; it often forms connections (usually only apparent) with the posterior roots of the first, more rarely of the second cervical nerve; it then passes behind the a. vertebralis through the foramen occipitale magnum into the skull cavity, unites with the superior root fibres and, passing in front of the tonsilla cerebelli below the n. vagus to the foramen jugulare, goes downward through this in a curve (see p. 731). On emergence from the foramen jugulare the n. accessorius divides into two branches (see Fig. 835):

1. *Ramus internus* (see Fig. 835), the smaller of the two, formed chiefly of the superior root fibres, unites with the n. vagus above the ganglion nodosum (see p. 731).

2. *Ramus externus* (see Figs. 834, 835, 837 and 845) runs behind or in front of the v. jugularis interna, behind the processus styloideus and its muscles and behind the venter posterior m. digastrici upon the proc. transversus atlantis downward and lateralward to the medial surface of the m. sternocleidomastoideus, usually to perforate the deep layer of this muscle, sometimes however to run past it on its medial surface. It anastomoses into the muscle with branches of the n. occipitalis minor (from C_2) and supplies the muscle in common with this nerve. At about the middle of the posterior margin of the m. sternocleidomastoideus it enters the regio colli lateralis (see Fig. 845) and goes downward and backward in its fatty layer to the anterior surface of the m. trapezius, in order to supply it in common with branches of the plexus cervicalis (see Figs. 844 and 845) (from the nn. cervicales II and III, or III and IV) with motor fibres.

XII. **N. hypoglossus** (s. Figs. 749, 750, 755, 758, 817, 819, 828, 833—835, 837, 844 and 847), motor, appears with 10—15 threads between the pyramid and the olive from the sulcus lateralis anterior of the medulla oblongata (see p. 649). The threads converge lateralward behind the a. vertebralis (see Fig. 833) to the canalis hypoglossi, enter the canal, usually in two bundles, more rarely as a single stem, through openings in the dura mater and run through it forward and lateralward as a single stem surrounded by the venous rete canalis hypoglossi. On emergence from the canal (see Figs. 835 and 837) the nerve lies medial from and behind the n. vagus, passes in front of the v. jugularis interna, behind the n. vagus, downward upon its lateral side (see Figs. 834, 835 and 837), goes downward and forward on it and on the lateral surface of the a. carotis interna, covered by the m. stylohyoideus and venter posterior m. digastrici, to the lateral side of the a. carotis externa (below the origin of the aa. occipitalis, maxillaris externa and sternocleidomastoidea) (see Figs. 485, 828 and 834) and then runs forward in a curve, convex below and behind, upon the lateral surface of the m. hyoglossus, there to break up into its terminal branches.


Ganglion cervicale medium
N. cardiacus medius
Ganglion thoracale I
Ansa subclavia [Vieussenii]
N. cardiacus inferior
N. cardiacus superior
Ramus cardiacus superior n. vagi
Arcus aortae
Plexus cardiacus
Ramus cardiacus inferior n. vagi
Ramus bronchialis anterior
Rami bronchiales posteriores
Bronchus sinister
Plexus pulmonalis posterior
Cut surface of the left lung
Plexus coronarius cordis posterior
Cor
Hook
Hepar
Omentum minus
Vesica fellea
Ganglion cervicale inferius
Ramus anterior n. cervicalis VIII
Ramus anterior n. thoracalis I
Branch to the plexus brachialis
Ramus anterior n. thoracalis II
N. intercostalis I
A. carotis communis sinistra
A. subclavia sinistra
N. vagus sinister
Rami pulmonales
N. recurrens
Rami communicantes
Ganglion thoracale VI
N. intercostalis VI
Rami oesophagei
Truncus sympathicus
Aorta thoracalis
Oesophagus
Plexus oesophageus anterior
N. splanchnicus major
N. splanchnicus minor
Branching of the n. vagus sinister
Ramus hepaticus
Rami gastrici
Ventriculus

839. Left n. vagus in the thoracic and abdominal cavities, viewed from the left.

(The ribs and the left lung have been almost wholly removed, the latter and the liver have been drawn to the right, the stomach to the left and downward; the diaphragm has been partly cut away; the pleura has been dissected off. Of the sympathicus only a few branches are drawn.)

XII. **N. hypoglossus** (continued). In front it crosses the medial surface of the m. stylohyoideus and venter posterior m. digastrici close above the hyoid bone (see Figs. 485, 828 and 834) and is covered externally by the glandula submaxillaris, v. facialis communis and platysma. Branches:

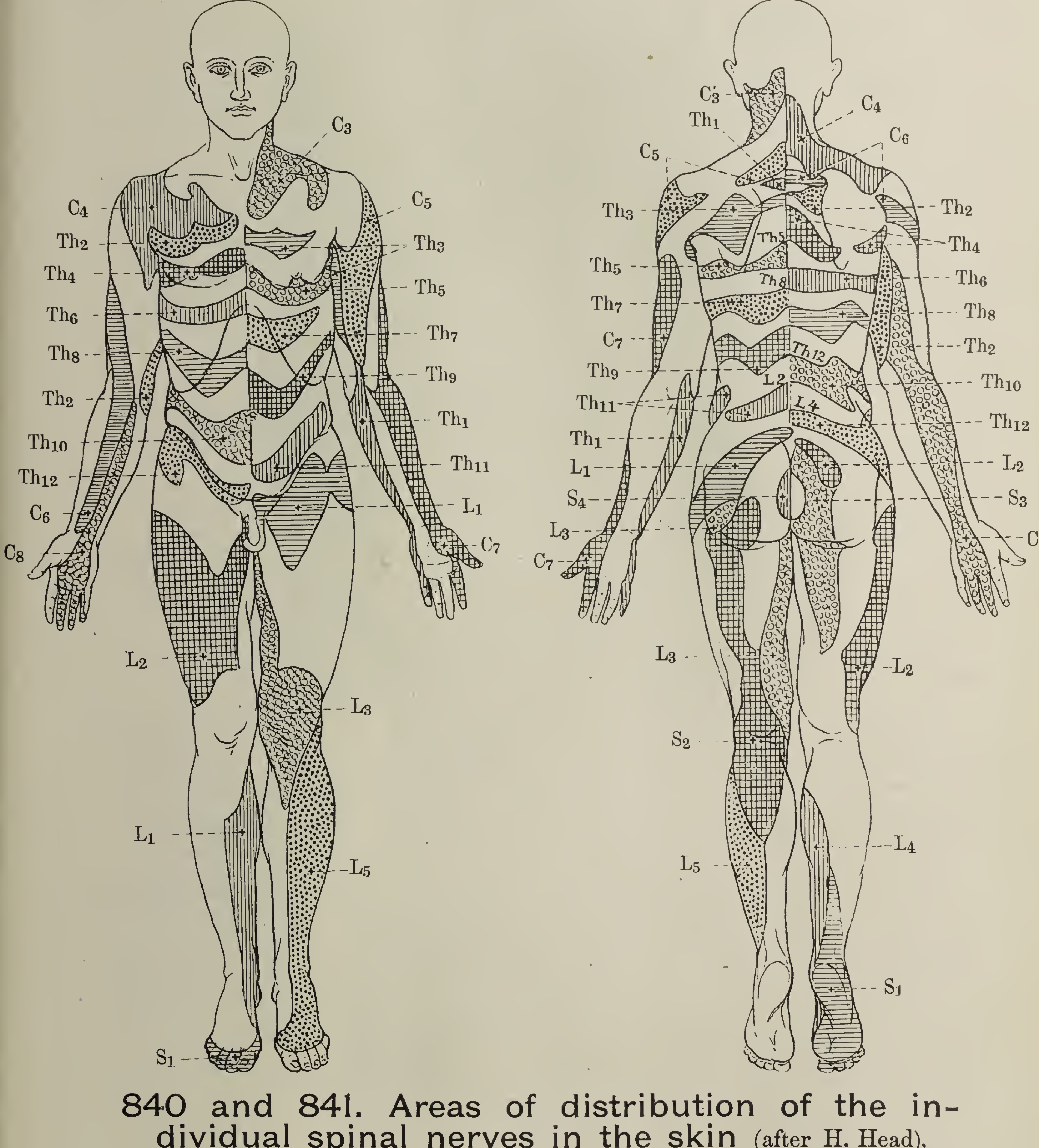
1. Anastomosis by a delicate thread between the upper end of the ganglion cervicale superius and the n. hypoglossus just under the canalis hypoglossi (not illustrated).
2. Anastomosis with the ganglion nodosum n. vagi (see Figs. 834 and 835).
3. Anastomosis with the ramus anterior n. cervicalis I (and II) (see Figs. 834, 835 and 844), by which motor fibres are brought to the n. hypoglossus for the mm. thyreohyoideus, omohyoideus, sternohyoideus, sternothyreoideus and geniohyoideus.
4. Delicate thread in the canalis hypoglossi running back to bone and sinus occipitalis.
5. *Ramus descendens* (see Figs. 828, 834, 844 and 847) usually goes off at the point where the n. hypoglossus crosses the a. carotis interna, passes downward upon it and upon the a. carotis communis (see also Fig. 358), often lying against the n. vagus, and communicates through one or several loops, *ansa hypoglossi* (see Figs. 832, 844 and 847), situated upon the lateral surface of the great vessels (sometimes also between them), with branches of the plexus cervicalis from the nn. cervicales II and III, which bring to it motor fibres for the mm. omohyoideus, sternothyreoideus and sternohyoideus. From this loop arise the branches for the muscles named.
6. *Ramus thyreohyoideus* (see Fig. 834) arises at the cornu majus oss. hyoidei and runs downward and forward to the lateral surface of the m. thyreohyoideus (for origin: vide supra).
7. *Rami linguales* (see Fig. 834), terminal branches, to the mm. geniohyoideus (fibres partly from C_1 [C_2], see also above), hyoglossus, styloglossus, genioglossus, longitudinales, transversus and verticalis linguae. They anastomose with each other and upon the m. hyoglossus with the branches of the n. lingualis (V) (see p. 723).

Nervi spinales, spinal nerves, go off from the spinal cord. They appear there (see Figs. 734, 740, 803 and 804) with two rows of *root threads, fila radicularia*, an anterior row at the sulcus lateralis anterior, a posterior row at the sulcus lateralis posterior (see p. 638); the former contains the motor, the latter the sensory fibres. The root threads of the anterior row converge in groups lateralward, each group forming a small stem, an *anterior root, radix anterior,* the posterior row situated at the same level, forming a *posterior root, radix posterior* (see Figs. 734, 740, 758 and 833). Each anterior passes with a posterior root toward the corresponding foramen intervertebrale (see below and Fig. 743), and the two there perforate the dura mater spinalis (see p. 643). The direction of the roots (see Figs. 734, 736, 737, 741, 742, 833 and 835), is horizontal for the uppermost cervical nerves, becomes more oblique lower down and caudalward descending more and more. The foramen intervertebrale for the inferior cervical nerves lies approximately one vertebral level lower, for the 1st—10th thoracic nerve two lower, than the level of emergence of the roots concerned from the spinal cord. The roots of the lowermost thoracic, of the lumbar, sacral and coccygeal nerves run downward for a considerable distance within the sack of the dura mater (see p. 642) before they leave it; they form in it a thick bundle of strands running longitudinally, the *cauda equina (horse's tail)* (see Figs. 737 and 742), in the middle of which lies the filum terminale. Each posterior root becomes swollen in the foramen intervertebrale to form the egg-shaped *spinal ganglion, ganglion spinale* (see Figs. 737, 740, 743 and 804), which contains the origin-cells of the sensory fibres, and lateralward from this fuses with the corresponding anterior root to form a (mixed) *n. spinalis, spinal nerve,* which divides after a short course, into a *ramus posterior* and a *ramus anterior* (see Figs. 742 and 743). The number of the spinal ganglia corresponds to that of the spinal nerves. The spinal ganglion of the first cervical nerve is very small, it and the posterior root being often absent; it lies in the sulcus a. vertebralis of the atlas. The ganglia of the lower lumbar nerves lie partly, those of the sacral nerves completely, within the canalis vertebralis or sacralis between the dura mater and the bone (see Fig. 742). The ganglion of the n. coccygeus lies at variable level inside the dura mater.

There are 31 nn. spinales on each side. They are divided (see Figs. 734 and 736) into 8 *nn. cervicales, cervical nerves,* of which the first emerges between the occipital bone and the atlas, the second between the atlas and the epistropheus, the eighth between the 7th cervical and 1st thoracic vertebra, 12 *nn. thoracales, thoracic nerves,* the first between the 1st and 2nd thoracic vertebra, the twelfth between the 12th thoracic and 1st lumbar vertebra, 5 *nn. lumbales, lumbar nerves,* 5 *nn. sacrales, sacral nerves* and 1 (2—3, see p. 642) *n. coccygeus, coccygeal nerve,* which emerge like the thoracic nerves. An increase in the number of vertebrae is accompanied by a corresponding increase in that of the spinal nerves.

In the 1st and 2nd cervical nerve the posterior branches are larger than the anterior, otherwise the reverse is true. Each anterior branch is connected by at least one fine thread, *ramus communicans,* with a ganglion of the sympathicus (see Figs. 743, 835, 839, 871, 876, 890 and 892). Besides, it gives off a *ramus meningeus* (not illustrated), which receives sympathetic threads from the ramus communicans, passes back through the foramen intervertebrale of its nerve into the vertebral canal, anastomoses with others and is distributed to the wall of the canal.

Neigboring nerves anastomose manifoldly with one another through *ansae, loops,* which are regular and large, on the anterior branches of the cervical, lumbar and sacral nerves.



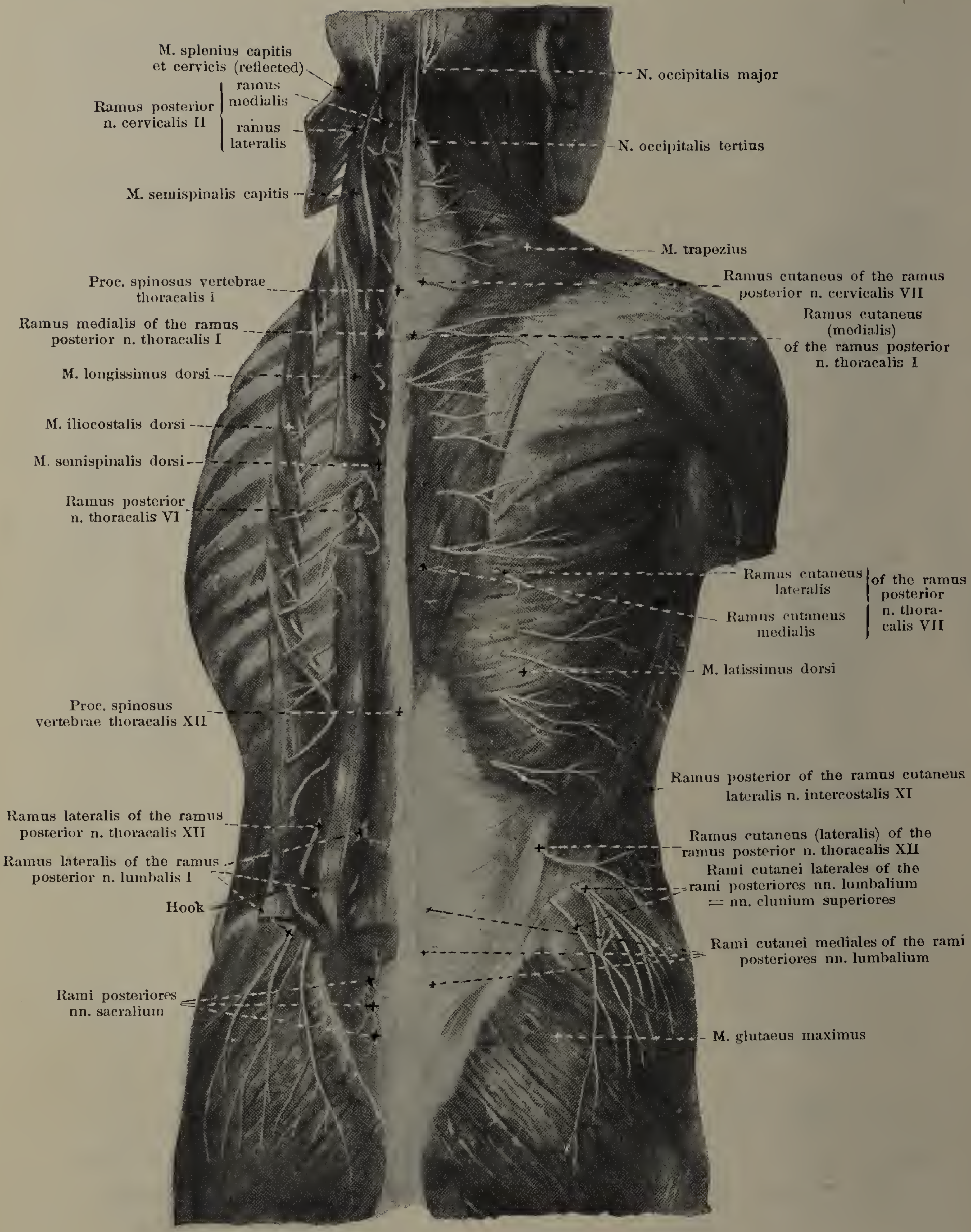
840 and 841. Areas of distribution of the individual spinal nerves in the skin (after H. Head),

viewed from in front. viewed from behind.

In reality the individual areas overlap one another more or less.

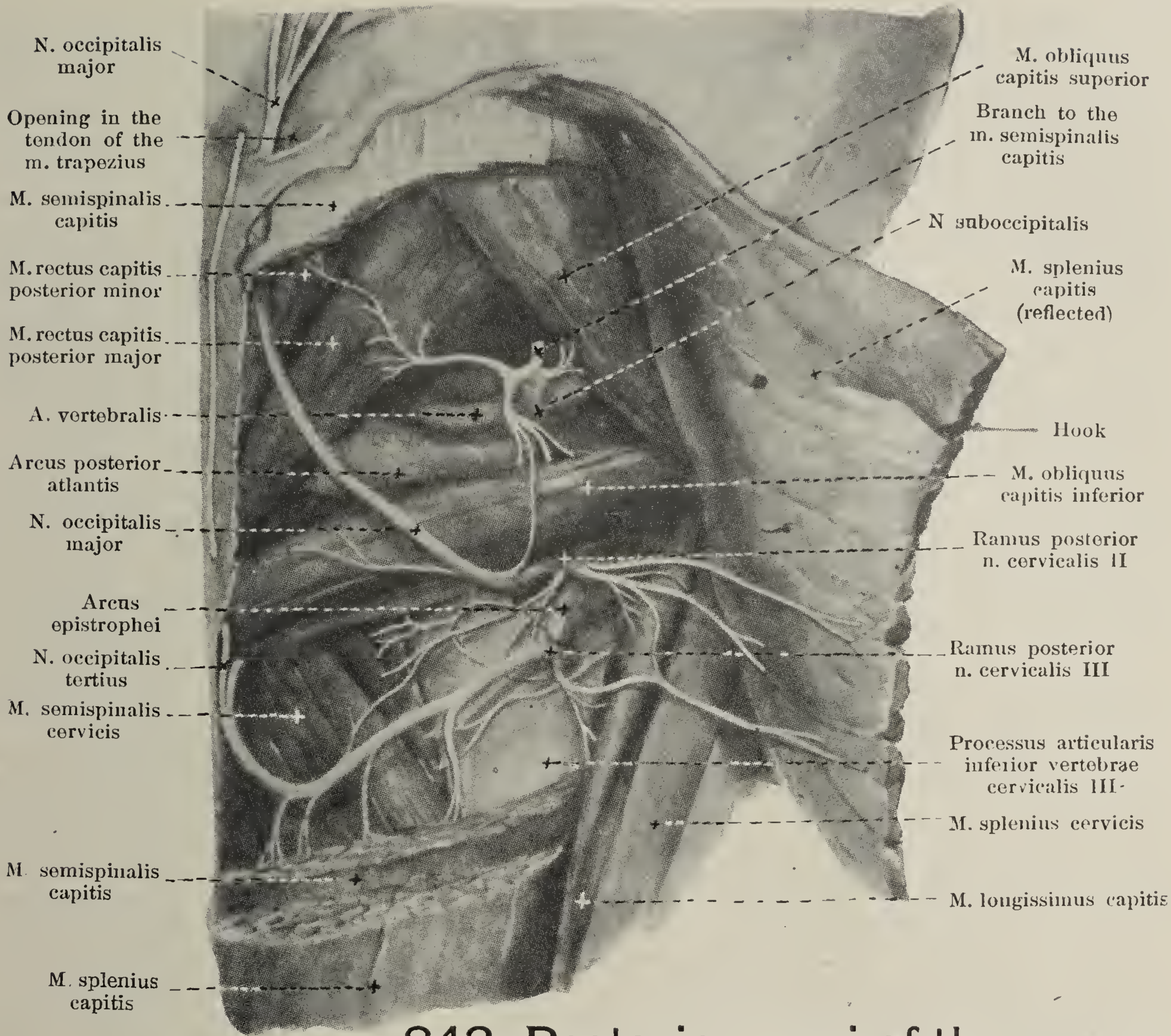
(The designation Th_5, L_2 etc. printed inside the Fig. 841 indicate the position of the proc. spinosus vertebrae thoracalis V, lumbalis II etc.. Concerning the other designations vide infra.)

Note: In the figures and descriptions of the spinal nerves means C = n. cervicalis, Th = n. thoracalis, L = n. lumbalis, S = n. sacralis, Co = n. coccygeus; thus C_5 = n. cervicalis V etc.


M. splenius capitis et cervicis (reflected)
Ramus posterior n. cervicalis II
ramus medialis
ramus lateralis
M. semispinalis capitis
Proc. spinosus vertebrae thoracalis I
Ramus medialis of the ramus posterior n. thoracalis I
M. longissimus dorsi
M. iliocostalis dorsi
M. semispinalis dorsi
Ramus posterior n. thoracalis VI
Proc. spinosus vertebrae thoracalis XII
Ramus lateralis of the ramus posterior n. thoracalis XII
Ramus lateralis of the ramus posterior n. lumbalis I
Hook
Rami posteriores nn. sacralium
N. occipitalis major
N. occipitalis tertius
M. trapezius
Ramus cutaneus of the ramus posterior n. cervicalis VII
Ramus cutaneus (medialis) of the ramus posterior n. thoracalis I
Ramus cutaneus lateralis
Ramus cutaneus medialis
of the ramus posterior n. thoracalis VII
M. latissimus dorsi
Ramus posterior of the ramus cutaneus lateralis n. intercostalis XI
Ramus cutaneus (lateralis) of the ramus posterior n. thoracalis XII
Rami cutanei laterales of the rami posteriores nn. lumbalium = nn. clunium superiores
Rami cutanei mediales of the rami posteriores nn. lumbalium
M. glutaeus maximus

842.

Posterior rami of the spinal nerves, viewed from behind. (On the left the shoulder girdle with its muscles, along with the mm. latissimus dorsi, rhomboidei and the fascia lumbodorsalis have been removed. The long muscles of the back have been isolated [see Figs. 387—389], and pieces have been cut out of them; the posterior surface of the sacrum is exposed.)


N. occipitalis major
Opening in the tendon of the m. trapezius
M. semispinalis capitis
M. rectus capitis posterior minor
M. rectus capitis posterior major
A. vertebralis
Arcus posterior atlantis
N. occipitalis major
Arcus epistrophei
N. occipitalis tertius
M. semispinalis cervicis
M. semispinalis capitis
M. splenius capitis
M. obliquus capitis superior
Branch to the m. semispinalis capitis
N suboccipitalis
M. splenius capitis (reflected)
Hook
M. obliquus capitis inferior
Ramus posterior n. cervicalis II
Ramus posterior n. cervicalis III
Processus articularis inferior vertebrae cervicalis III
M. splenius cervicis
M. longissimus capitis

843. Posterior rami of the upper cervical nerves of the right side, viewed from behind. (The m. splenius capitis has been reflected lateralward, the m. semispinalis capitis has been for the most part removed, the m. trapezius completely removed.)

The **rami posteriores nn. spinalium** (see also Figs. 743 and 842) with the exception of the three upper cervical nerves are smaller than the anteriores. In a typical nerve (middle thoracic) each ramus posterior passes dorsalward medial from the ligg. costotransversarium anterius and intertransversarium (mm. intertransversarius posterior for the cervical nerves, lateralis for the lumbar nerves), and divides (excepting the first cervical, fourth and fifth sacral and the coccygeal nerves) into a *ramus medialis* and a *ramus lateralis*, which enter the musculature and of which usually only one (in the upper half the medial, in the lower half the lateral) goes to the skin. Almost all the rami run also caudalward, especially the lower ones, so that their distribution in muscle and skin lies below their emergence from the foramen intervertebrale (see Figs. 841 and 842). The rami behave differently at different levels.

A. ***Rami posteriores nn. cervicalium*** (see also Figs. 835 and 842). Each *ramus lateralis* passes lateralward around the m. semispinalis capitis and branches on it (C_1—C_4), on the m. intertransversarius posterior (C_2—C_8), the mm. longissimi capitis (C_1—C_3 [C_4]) and cervicis ([C_3] C_4—C_8) and the splenius (C_1—C_4 [C_5]). The *ramus medialis* supplies the mm. semispinalis capitis (C_1—C_4) and cervicis (C_3—C_6 [C_7]), between which it runs, and also the mm. multifidus, rotatores, interspinales and spinalis cervicis (C_3—C_8); near the proc. spinosus it perforates the mm. semispinalis capitis and trapezius (true usually only of the 4th—6th cervical nerve), to bend around lateralward as the *ramus cutaneus* to the skin. The course and distribution of the posterior rami of the first, second and third cervical nerve deviate somewhat.

Ramus posterior n. cervicalis I=N. suboccipitalis, considerably larger than the corresponding anterior ramus, purely motor, passes backward under the a. vertebralis in the triangle between the mm. obliqui capitis and rectus capitis posterior major. It supplies these muscles as well as the mm. rectus capitis posterior minor and semispinalis capitis, longissimus capitis and splenius, gives off branches to the articulatio atlantooccipitalis and anastomoses with the posterior branch of the 2nd cervical nerve.

Ramus posterior n. cervicalis II (see Figs. 842 and 843), the largest posterior ramus of all, divides at the inferior margin of the m. obliquus capitis inferior into a small *ramus lateralis* and a large *ramus medialis.* The former sends motor branches to the mm. semispinalis capitis, longissimus capitis and splenius; the latter anastomoses with the posterior branches of the first and third cervical nerve, gives motor fibres to the mm. semispinalis capitis and obliquus capitis inferior and, with its main mass as the sensory *n. occipitalis major,* passes in a curve medianward and upward between the m. semispinalis capitis on the one side, the mm. obliquus capitis inferior and recti capitis posteriores on the other side, perforates the m. semispinalis capitis near the lig. nuchae and goes through an opening in the tendon of the m. trapezius (see Fig. 347) to run under the skin. Its branches go upward as far as the vertex (see Figs. 830, 832 and 845) and anastomose with one another and with branches of neighboring nerves.

Ramus posterior n. cervicalis III (see Figs. 842 and 843) differs from the inferior cervical nerves in that the end of its ramus medialis, as the sensory *n. occipitalis tertius,* after perforation of the mm. semispinalis capitis and trapezius goes either to the adjacent skin (see Fig. 845) or passes upward connected wholly or in part with the n. occipitalis major.

B. ***Rami posteriores nn. thoracalium*** (see Figs. 743 and 842). Each *ramus lateralis* passes lateralward between the mm. longissimus and iliocostalis dorsi and usually on the 7th or 8th—12th thoracic nerve gives off through the m. latissimus dorsi a branch to the skin, *ramus cutaneus lateralis,* lateralward and somewhat downward, that for the 12th nerve reaching the crista iliaca. The *ramus medialis* goes medianward toward a proc. spinosus between the mm. longissimus and semispinalis dorsi, that for the 1st—7th or 8th nerve usually gives off through the m. trapezius a *ramus cutaneus medialis* lateralward. The rami mediales decrease in size downward, the laterales increase. The rami laterales supply the mm. iliocostalis and longissimus, the rami mediales the mm. rotatores, multifidus, interspinales (Th_1—Th_{12}), semispinalis dorsi ([Th_3] Th_4—Th_6, Th_{11}, Th_{12}), and spinalis dorsi (Th_2, Th_6—Th_8).

C. ***Rami posteriores nn. lumbalium*** (see Fig. 842). The *rami laterales* pass obliquely lateralward through the m. sacrospinalis, supply it and the mm. intertransversarii mediales (L_1—L_5) and decrease in size below. The three upper usually send skin branches through the fascia lumbodorsalis close above the crista iliaca, the *nn. clunium superiores* (see also Figs. 879 and 886), which go downward to the buttock (lateralward as far as the trochanter major). The small *rami mediales* extend medianward to the m. multifidus and to the short muscles (L_1—L_5); the three lower ones send very delicate branches to the skin of the sacral region.

D. ***Rami posteriores nn. sacralium et n. coccygei*** (see Fig. 842), very delicate. The four upper ones emerge through the foramina sacralia posteriora, those of the 5th sacral and coccygeal nerve through the hiatus sacralis between the ligg. sacrococcygea posteriora (see Fig. 742). They anastomose with one another upon the posterior surface of the sacrum. ***Rami laterales*** are present only on the three upper sacral nerves; they perforate the origin of the m. glutaeus maximus and there go as *nn. clunium medii* to the skin (see Figs. 879 and 886). The *rami mediales* go to the m. sacrolumbalis and send most delicate branches to the skin (like the preceding).

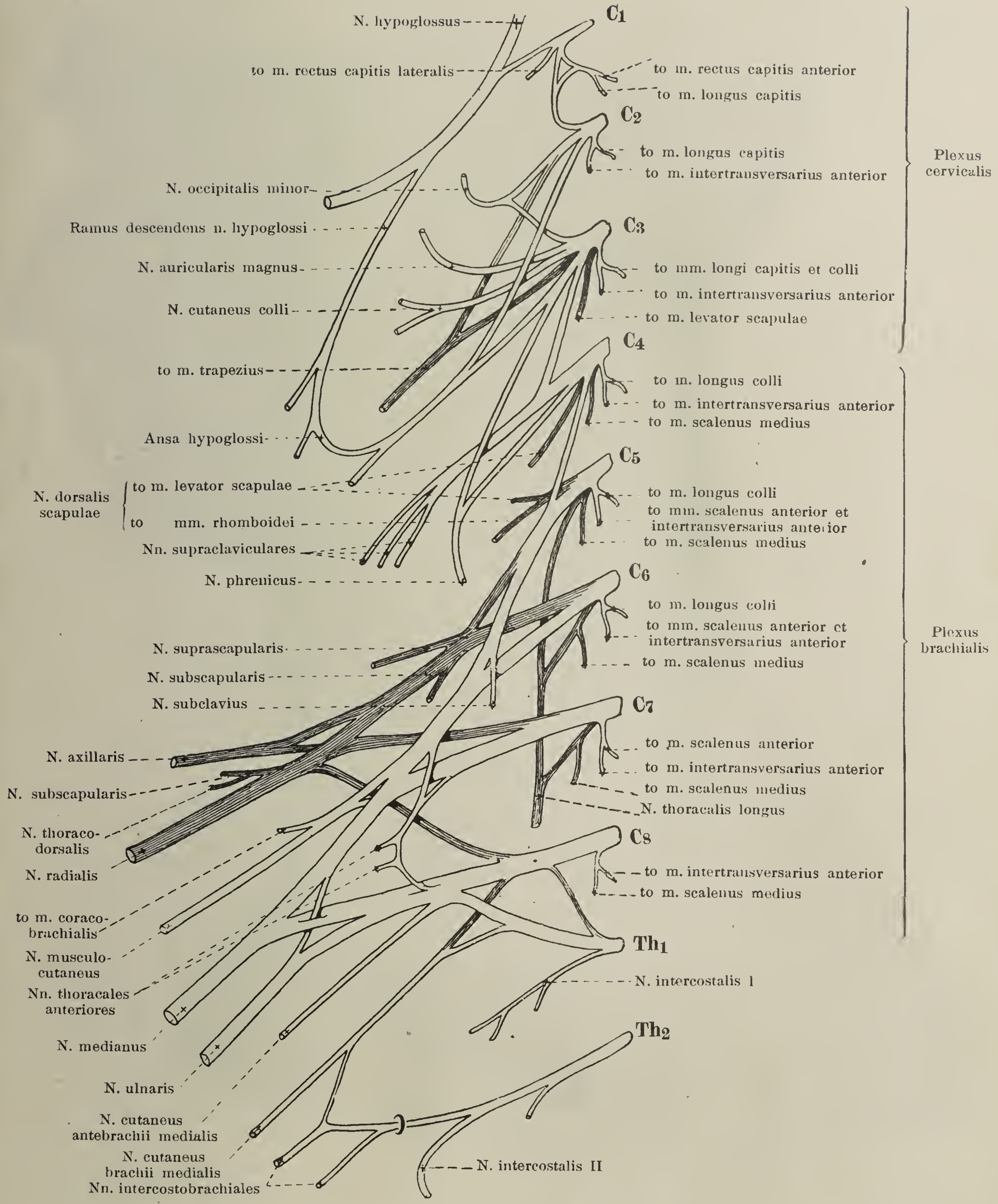
The **rami anteriores nn. spinalium** remain independent in their course only in the region of the thoracic nerves. In the cervical, lumbar and sacral regions they form connections with one another, at the same time dividing, so as to give rise to complicated plexusses, *plexus,* of which there are three on each side, *plexus cervicalis, brachialis* and *lumbosacralis.*

Rami anteriores nn. cervicalium. Those for the 3rd—8th nerve run lateralward behind the a. vertebralis in the sulcus n. spinalis of the corresponding vertebra (see Fig. 835) between the mm. intertransversarii anterior and posterior; they appear lateral from the mm. longi capitis and colli and the origins of the m. scalenus anterior, medial and in front of the origins of the mm. splenius cervicis, levator scapulae and scalenus medius (see Fig. 834). That of the first nerve goes forward under the a. vertebralis (see Figs. 833 and 835) and appears between the mm. recti capitis anterior and lateralis; that of the second (see Fig. 835) grasps the a. vertebralis from behind and without and turns forward, medial from the m. intertransversarius posterior.

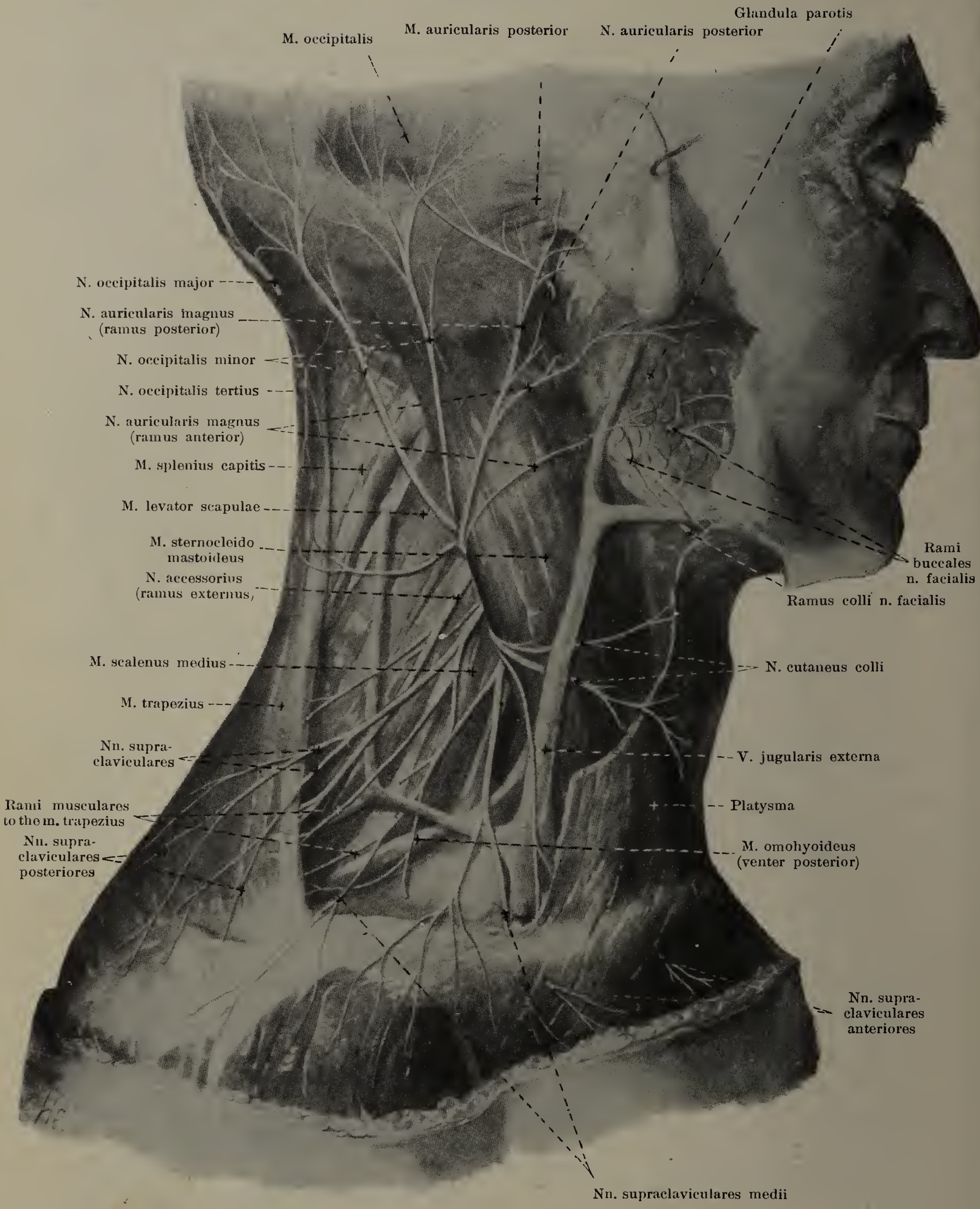
The anterior rami of the 1st—4th cervical nerve anastomose with one another and thus form the ***plexus cervicalis, cervical plexus*** (see Figs. 834, 835 and 844). This, covered by the m. sternocleidomastoideus, attached to the fascia praevertebralis, lies in front of the origins of the mm. splenius cervicis, levator scapulae and scalenus medius. The plexus communicates with the main trunk and ramus descendens of the n. hypoglossus (see p. 736), as well as with the ganglion cervicale superius and the truncus sympathicus (see Fig. 835) by rami communicantes, at least one for each cervical nerve. The rami of the plexus are divisible into cutaneous and muscular branches.

A. *Cutaneous branches* (see Figs. 830 and 845), appear at the middle of the posterior margin of the m. sternocleidomastoideus:

1. *N. occipitalis minor* (see Figs. 832, 844 and 845), from C_2 and C_3, runs upward at the posterior margin of the m. sternocleidomastoideus upon this and the m. splenius, and sends its terminal branches to the skin of the lateral occipital and the temporal region; it anastomoses with branches of the nn. auricularis posterior (VII) occipitalis major and auricularis magnus. A few branches help to supply the m. sternocleidomastoideus and anastomose in it with branches of the n. accessorius.



844. Right plexus cervicalis and brachialis,
schematic (after P. Eisler) (The rami communicantes are not shown.)
(The darkly shaded strands are derivatives of the dorsal half of the plexus.)


M. occipitalis
M. auricularis posterior
N. auricularis posterior
Glandula parotis
N. occipitalis major
N. auricularis magnus (ramus posterior)
N. occipitalis minor
N. occipitalis tertius
N. auricularis magnus (ramus anterior)
M. splenius capitis
M. levator scapulae
M. sternocleido mastoideus
N. accessorius (ramus externus)
M. scalenus medius
M. trapezius
Nn. supraclaviculares
Rami musculares to the m. trapezius
Nn. supraclaviculares posteriores
Rami buccales n. facialis
Ramus colli n. facialis
N. cutaneus colli
V. jugularis externa
Platysma
M. omohyoideus (venter posterior)
Nn. supraclaviculares anteriores
Nn. supraclaviculares medii

845. Cutaneous branches of the right plexus cervicalis, viewed from the right.

(The platysma has been partially removed.)

2. *N. auricularis magnus* (see Figs. 832, 844 and 845), from C_3, usually the largest branch, ascends in front of the preceding upon the lateral surface of the m. sternocleidomastoideus behind the v. jugularis externa, vertically to the ear. At the level of the angulus mandibulae it undergoes division. The smaller *ramus anterior* passes forward and upward under the ear, and passes sometimes partly through the parotid gland, to the skin of the lateral inferior half of the face (see Fig. 830), as well as to that of the lobule of the ear and of the concave surface of the auricula. The *ramus posterior* runs behind the ear to the skin on the convex side of the auricula and forward as far as the skin of the temporal region. It anastomoses with branches of the nn. auricularis posterior (VII) and occipitalis minor.

3. *N. cutaneus colli* (see Figs. 844 and 845), from C_3, or C_2 and C_3, passes forward, under the foregoing, upon the lateral surface of the sternocleidomastoideus, covered by the platysma, medial or lateral from the v. jugularis externa. It divides into *rami superiores* of which one unites with the ramus colli n. facialis (see Fig. 832 and p. 725), and *rami inferiores*. They perforate the platysma, are all sensory and go to the skin of the regio sternocleidomastoidea and of the regio colli anterior upward as far as the margin of the lower jaw.

4. *Nn. supraclaviculares* (see Figs. 844, 845, 850, 852, 864 and 865) from C_3 and C_4, usually from a small trunk, run superficially, covered only by the platysma, through the fossa supraclavicularis major, diverging downward, and divide into three groups:

a) *Nn. supraclaviculares anteriores* pass downward upon the v. jugularis externa and in front of the clavicle and through the platysma to the skin down under the medial part of the clavicle.

b) *Nn. supraclaviculares medii* go downward in front of the clavicle to the skin over the clavicle and over the m. pectoralis major as far as the region of the nipple.

c) *Nn. supraclaviculares posteriores* pass downward and backward upon the m. trapezius to the skin over the m. deltoideus, rarely still farther distalward.

B. *Muscular branches*, partly directly from the cervical nerves (see Fig. 844):

1. For the mm. rectus capitis lateralis from C_1, rectus capitis anterior from C_1 and C_2, longus capitis from C_1—C_3, longus colli from C_2—C_6, scalenus medius from (C_4) C_5—C_8, levator scapulae from (C_2) C_3—C_4 and intertransversarii anteriores from C_2—C_8.

2. Branch to the ramus descendens hypoglossi (see Figs. 834 and 844), from C_2 and C_3; it helps to form the ansa hypoglossi (see p. 736) under the m. sternocleidomastoideus.

3. Branches to the m. sternocleidomastoideus (C_2), from n. occipitalis minor (see p. 740).

4. Branch for the m. trapezius (see Figs. 844 and 845), from C_2 and C_3, or C_3 and C_4, frequently a branch of the nn. supraclaviculares posteriores; anastomosis with the n. accessorius.

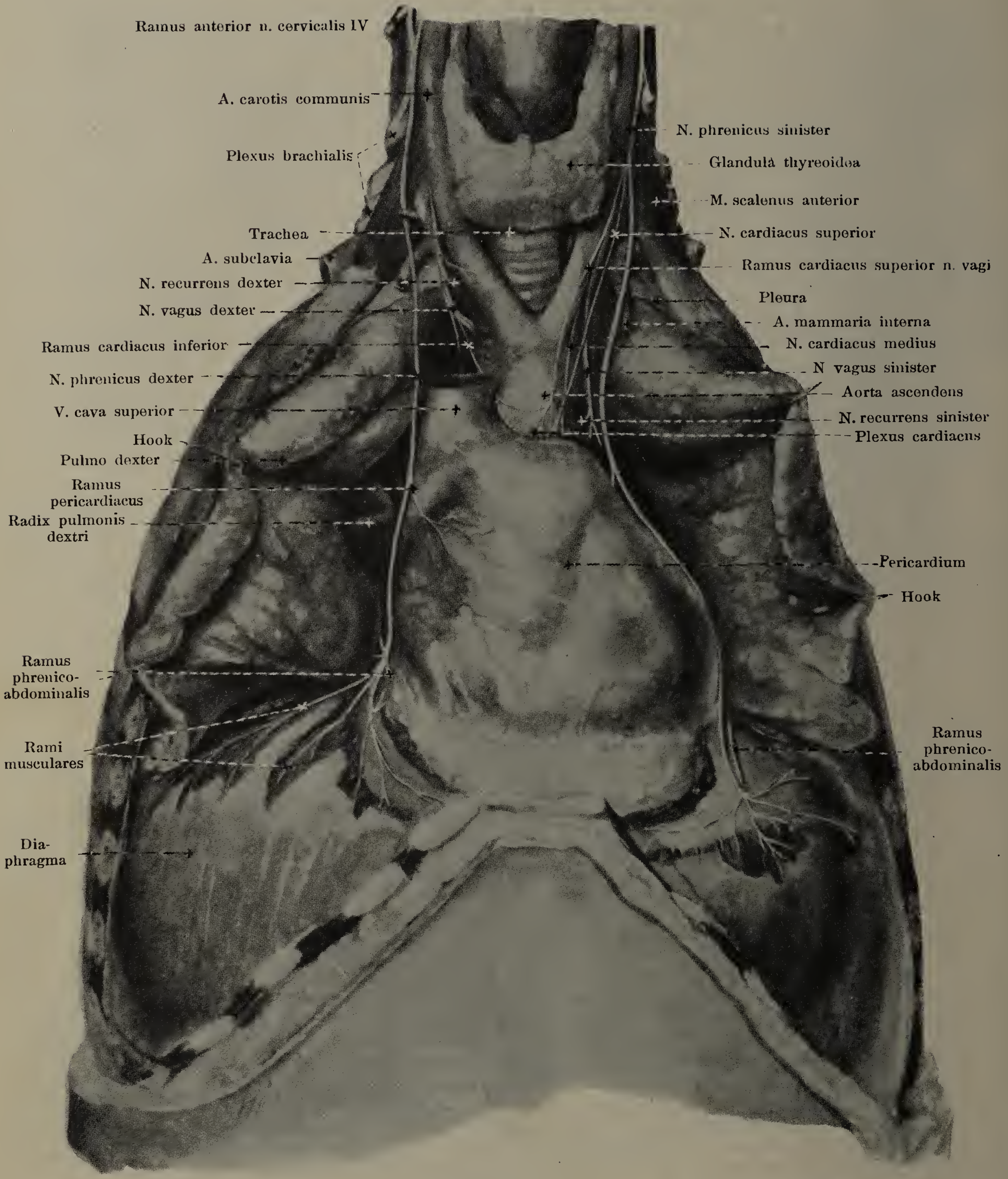
5. *N. phrenicus* (see Figs. 834, 838, 844, 846 and 847), a mixed nerve, from C_3 and C_4 or C_4 and C_5, with the largest root from C_4, passes downward and somewhat medianward upon the anterior surface of the m. scalenus anterior (see Fig. 838), lateral from the a. cervicalis ascendens, runs between the a. and v. subclavia, lateral from the truncus thyreocervicalis and n. vagus, in front of or behind the a. mammaria interna, to the anterior medial declivity of the cupula pleurae, and enters the thoracic cavity behind the articulatio sternoclavicularis. There it passes under the pleura mediastinalis along with the a. pericardiacophrenica in front of the root of the lung to the pericardium and then between this and the pleura pericardiaca to the diaphragm (see also Figs. 680—682). In its course on the right side it lies on the lateral surface of the v. anonyma dextra and vena cava superior, close in front of the radix pulmonis, and reaches the diaphragm somewhat in front of and lateral from the foramen venae cavae. On the left side it runs lateral from the arcus aortae, lies farther ventral from the root of the lung and reaches the diaphragm farther lateralward and forward than on the right side. It communicates by delicate threads with the ganglion cervicale inferius of the sympathicus and very often receives a branch from the n. subclavius (see Fig. 847). Branches (see Fig. 846):

a) *Ramus pericardiacus*, usually right only, upon the v. cava superior to the pericardium.

b) Very delicate branches to the pleura (not illustrated).

c) Terminal branches, perforate the diaphragm; as *rami musculares* they innervate the musculature from the concave side and give some threads to the serosa of the diaphragm; as *rami phrenicoabdominales* they anastomose with the plexus phrenicus of the sympathicus, and send threads to the tunica serosa of the liver and to the suprarenal glands.

The anterior rami of the 5th—8th cervical nerve together with a small part of the 4th cervical nerve, with the upper, larger part of the 1st thoracic nerve and very often with a delicate branch of the 2nd thoracic nerve form the ***plexus brachialis,*** *arm plexus* (see Figs. 838, 839, 844, 847, 849 and 890). Its roots pass lateralward behind the origins of the m. scalenus anterior, in front of those of the m. scalenus medius; the 5th—7th cervical nerve runs at the same time markedly downward, the 8th horizontally, the 1st (and 2nd) thoracic nerve upward in front of the neck of the 1st rib. They unite to form an elongated plexus which lies in the space between the mm. scaleni anterior and medius, with its three upper root portions over, and with the two lower behind, the a. subclavia, thence the plexus, narrowed, passes immediately adjacent to the artery, behind the clavicle and the mm. subclavius and pectorales into the axilla.

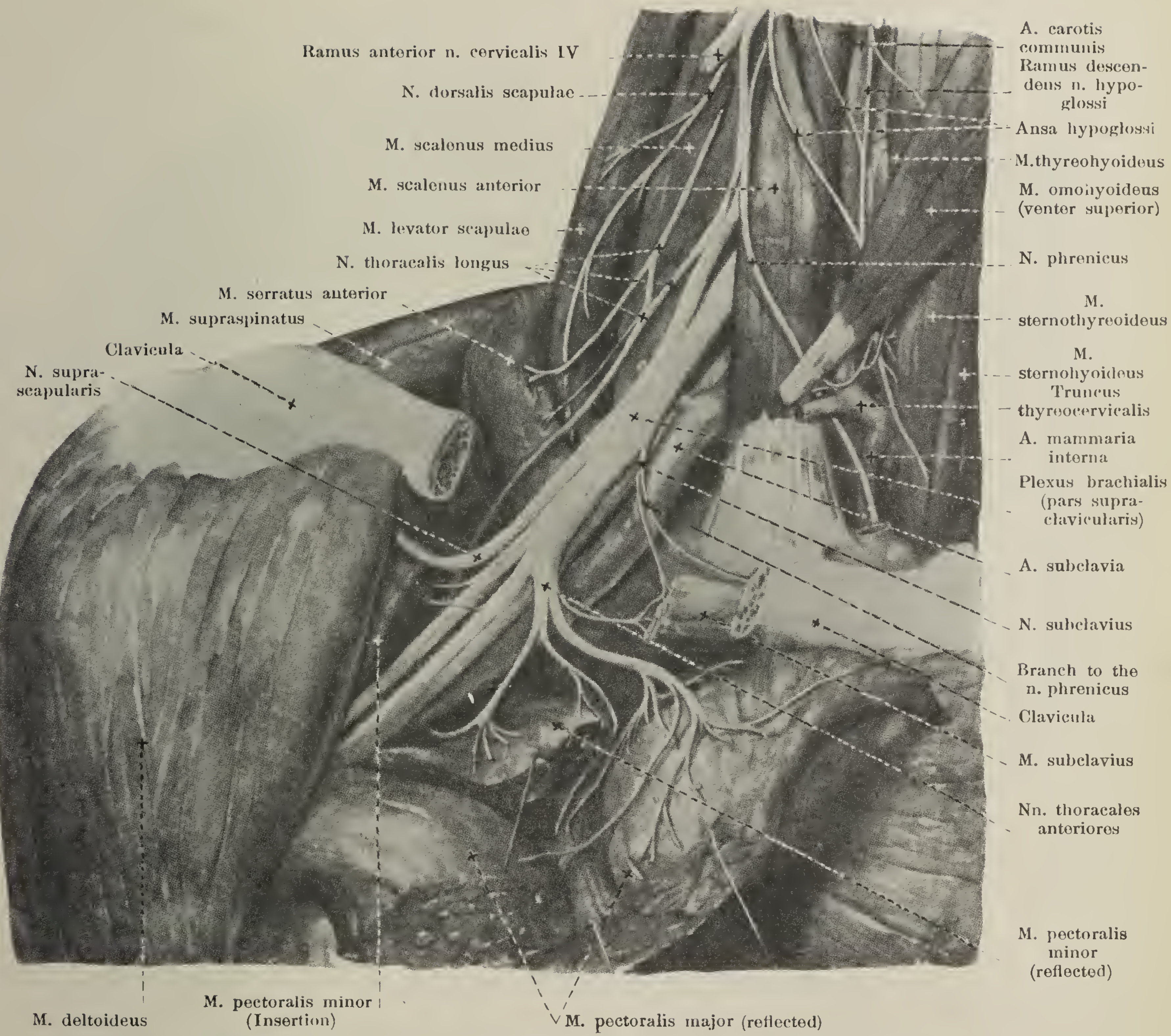


846. Nn. phrenici, viewed from in front.

(The anterior wall of the thorax has been removed; the thymus has been cut away and the pleura dissected off. The lungs have been drawn aside by hooks.)

Plexus brachialis (continued). Each of the nerves composing it sends off a ramus communicans to the ganglion cervicale medium or inferius of the sympathicus, before it enters the plexus (see Figs. 839 and 890).

The plexus is divisible into a *pars supraclavicularis* and a *pars infraclavicularis.*



847. **Right plexus brachialis with its short branches,** viewed from in front.

(The mm. sternocleidomastoideus and trapezius have been completely, the mm. omohyoideus and subclavius partially removed; a piece has been sawn out of the clavicle; the mm. pectorales have been incised and reflected.)

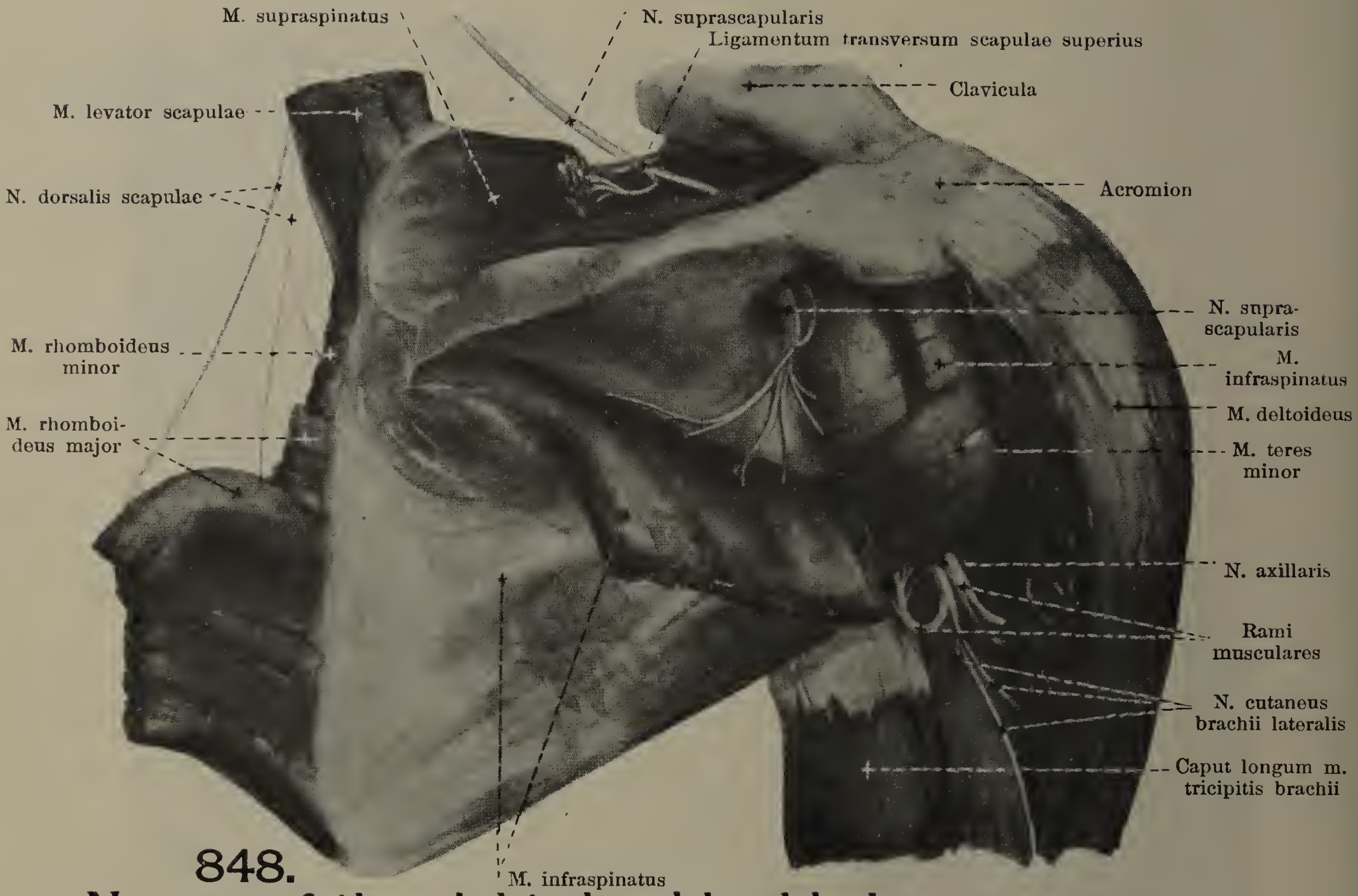
The ***pars supraclavicularis*** of the ***plexus brachialis*** reaches distalward as far as the clavicle, adjoins the mm. scalenus medius and serratus anterior dorsalward, is perforated (usually between C_6 and C_7) by the a. transversa colli and is crossed in front by the posterior belly of the m. omohyoideus and by the aa. cervicalis superficialis and transversa scapulae; all the short branches are counted as belonging to it, even if they are not given off until the axillary fossa is reached; these are the branches which run to the deep muscles of the neck and to those of the shoulder girdle.

1. Threads (directly from the trunks of the cervical nerves) for the mm. longus colli, scalenus medius and intertransversarii (see p. 743) and a root of the n. phrenicus (see p. 743).

2. Direct branches (from the trunks of the cervical nerves) to the mm. scalenus anterior from (C_4) C_5—C_7, scalenus posterior from C_7 or C_8 (see Fig. 844), and scalenus minimus from C_8, also to uppermost m. levator costae from C_8, and often to m. serratus posterior superior from C_8.

3. *Nn. thoracales posteriores* (see also Figs. 838, 844 and 848) appear through the m. scalenus medius. To this belong:

a) *N. dorsalis scapulae* (see also Fig. 848), from (C_4) C_5, runs downward on the anterior surface of the m. levator scapulae, the lowermost tooth of which it supplies (see also p. 743), to the ventral surface of the mm. rhomboidei (C_5), in which it ends.



848.

Nerves of the right shoulder blade, viewed from behind.

(The mm. supraspinatus and deltoideus have been partially cut away, the infraspinatus reflected.)

b) *N. thoracalis longus* (see Figs. 838, 844, 847, 849 and 869), from C5, **C6**, **C7**, **(C8)**, the roots of which usually unite first in front of the m. scalenus medius, descends behind the plexus brachialis, nearly in the axillary line, upon the lateral surface of the m. serratus anterior giving branches dorsalward to the single digitations of this muscle.

4. *N. subclavius* (see Figs. 844 and 847), from C_5 (C_6), in front of the a. subclavia, in front of or behind the v. subclavia, to the m. subclavius, sends a branch medianward to the n. phrenicus (see p. 743).

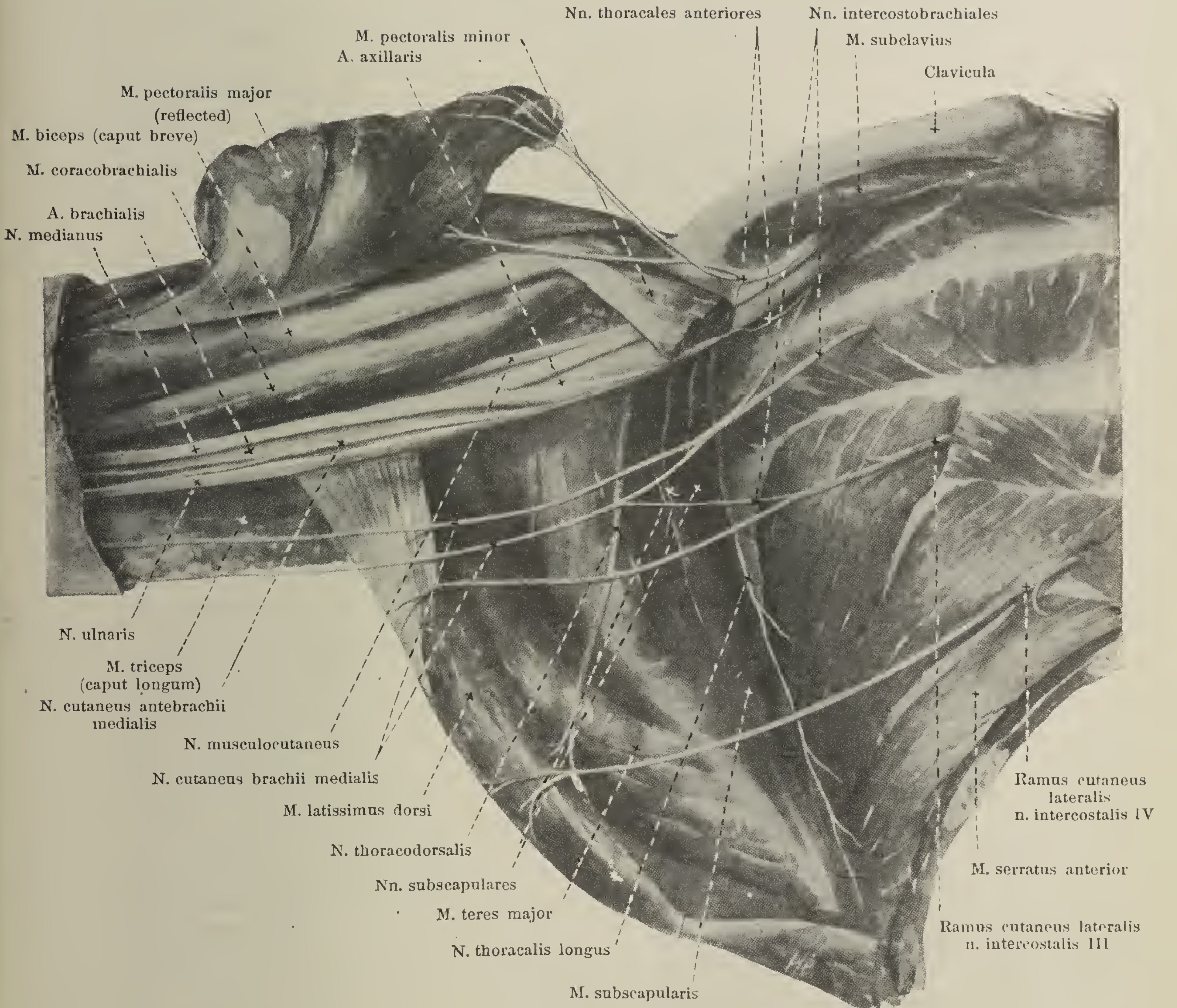
5. *Nn. thoracales anteriores* (see Figs. 844, 847 and 849), from C_5—Th_1, usually two, run forward and downward in front of and behind the artery, then between the a. and v. subclavia, anastomosing, to the mm. pectoralis minor (C_7, C_8) and pectoralis major (C5, **C6**, **C7**, **C8**, Th1).

6. *N. suprascapularis* (see also Figs. 844 and 847), from (C_4), C_5 and C_6, large, passes lateralward near the lateral part of the a. transversa scapulae under the m. trapezius and venter posterior m. omohyoidei and under the clavicle; it then passes beneath the lig. transversum scapulae superius into the fossa supraspinata, and behind the collum scapulae in front of the lig. transversum scapulae inferius into the fossa infraspinata. It supplies the mm. supraspinatus ([C_4], C_5, [C_6]) and infraspinatus ([C4], **C5**, C6) and gives off branches to the shoulder-joint.

7. *Nn. subscapulares* (see Figs. 844, 849 and 854), from C_5—C_7, usually two, from the dorsal surface of the plexus or from the n. axillaris; they run downward on the ventral surface of the m. subscapularis to this (C_5, C_6, [C_7]) and to the m. teres major (C_6, C_7).

8. *N. thoracodorsalis* (see Figs. 844, 849 and 854), from (C6), **C7** and C8, arises like 7), passes along the margo axillaris scapulae to the anterior surface of the m. latissimus dorsi.

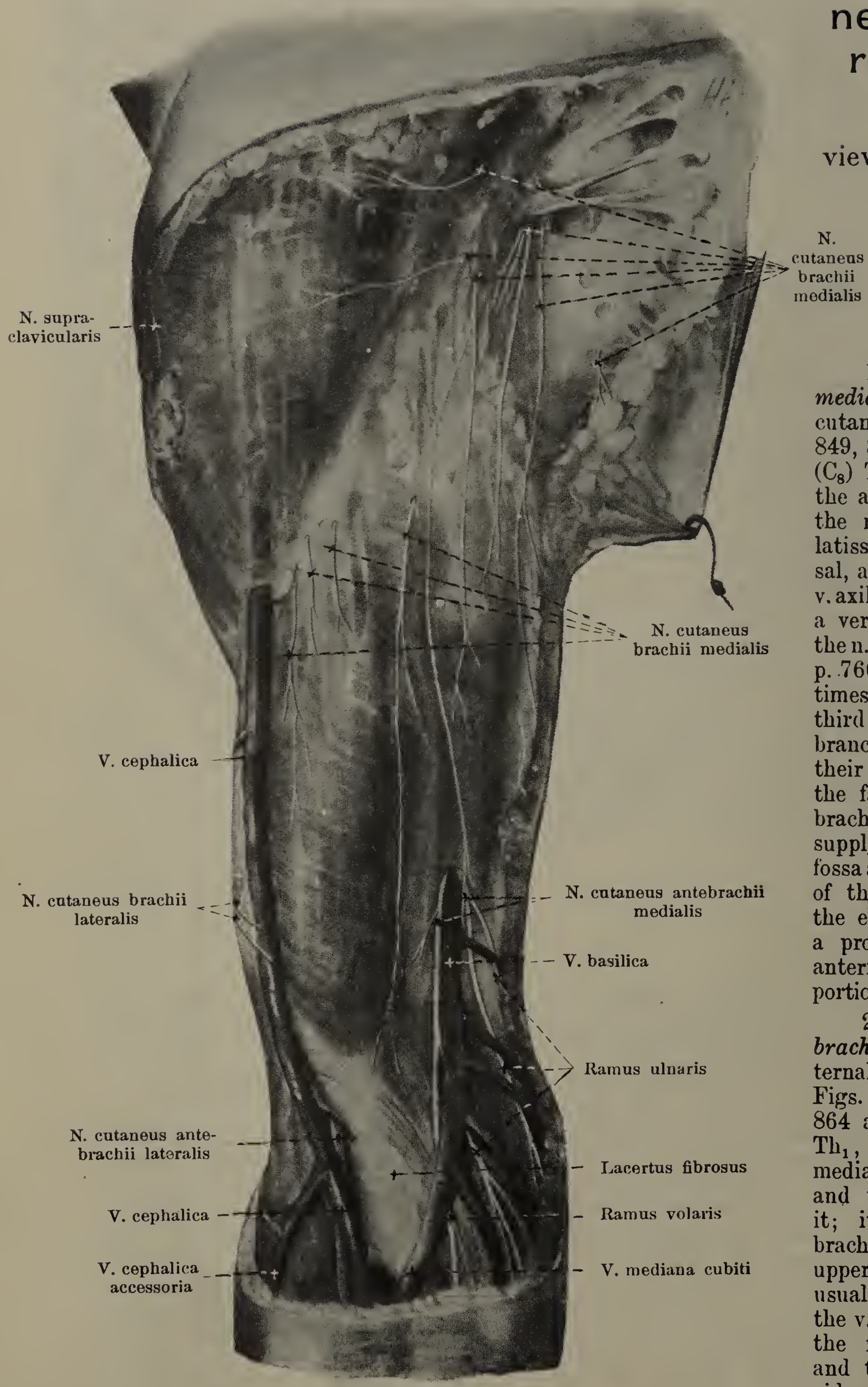
9. *N. axillaris* (see also Figs. 844, 852, 854, 862, 864 and 865) (O. T. circumflex nerve), from C_5, C_6 (C_7), large, arises in the axillary fossa from the fasciculus posterior of the pars infraclavicularis (see p. 747), runs behind the a. axillaris with the a. circumflexa humeri posterior, at first backward between the humerus, m. subscapularis, m. teres minor, caput longum m. tricipitis and teres major, then lateralward upon the collum chirurgicum, covered by the m. deltoideus. It sends branches to the shoulder-joint, *rami musculares* to the mm. teres minor (C5, **C6**, [C7]) and deltoideus (**C5**, C6) and gives off also the *n. cutaneus brachii lateralis* (C_5, C_6, [C_7]) between the m. deltoideus and the caput longum m. tricipitis to the skin over the posterior and lateral part of the upper arm. Some of the nerves supplying the m. deltoideus give off branches which pass through the muscle to the skin. The lower cutaneous branches anastomose with the nn. cutanei brachii posterior and antebrachii dorsalis.



849. Right plexus brachialis (pars infraclavicularis) in the axillary fossa, viewed from below and in front.

(The mm. pectorales major et minor have been in large part removed; the attachment of the former has been reflected.)

The *pars infraclavicularis* of the *plexus brachialis* (see also Figs. 847 and 854) passes distalward from the clavicle through the axillary fossa and breaks up in its lower half into its branches, which may also be designated as the long branches of the plexus; they go exclusively to the arm. It is bounded medianward by the m. serratus anterior, dorsalward by the m. subscapularis, is covered in front by the mm. pectorales and distalward lies, with its branches, in the groove between the mm. subscapularis and latissimus dorsi on the one side and the m. coracobrachialis on the other. The constituents of the plexus are arranged in three cords, which lie in direct contact with the a. axillaris, the *fasciculus posterior* running dorsalward, the *fasciculus lateralis* (when the arm is elevated horizontally) above and lateralward, and the *fasciculus medialis* below and medianward from the artery. The v. subclavia and the v. axillaris lie directly in front of and medianward from this bundle of the nerves and artery. From the fasciculus medialis proceed the *nn. cutaneus brachii medialis, cutaneus antebrachii medialis, ulnaris,* and the inferior root of the *n. medianus,* from the fasciculus lateralis the upper root of the *n. medianus* and the *n. musculocutaneus,* from the fasciculus posterior the *nn. axillaris* (see p. 746) and *radialis.*


N. cutaneus brachii medialis
N. supraclavicularis
N. cutaneus brachii medialis
V. cephalica
N. cutaneus brachii lateralis
N. cutaneus antebrachii medialis
V. basilica
Ramus ulnaris
N. cutaneus antebrachii lateralis
Lacertus fibrosus
V. cephalica
Ramus volaris
V. cephalica accessoria
V. mediana cubiti

850.

Cutaneous nerves of the right upper arm,

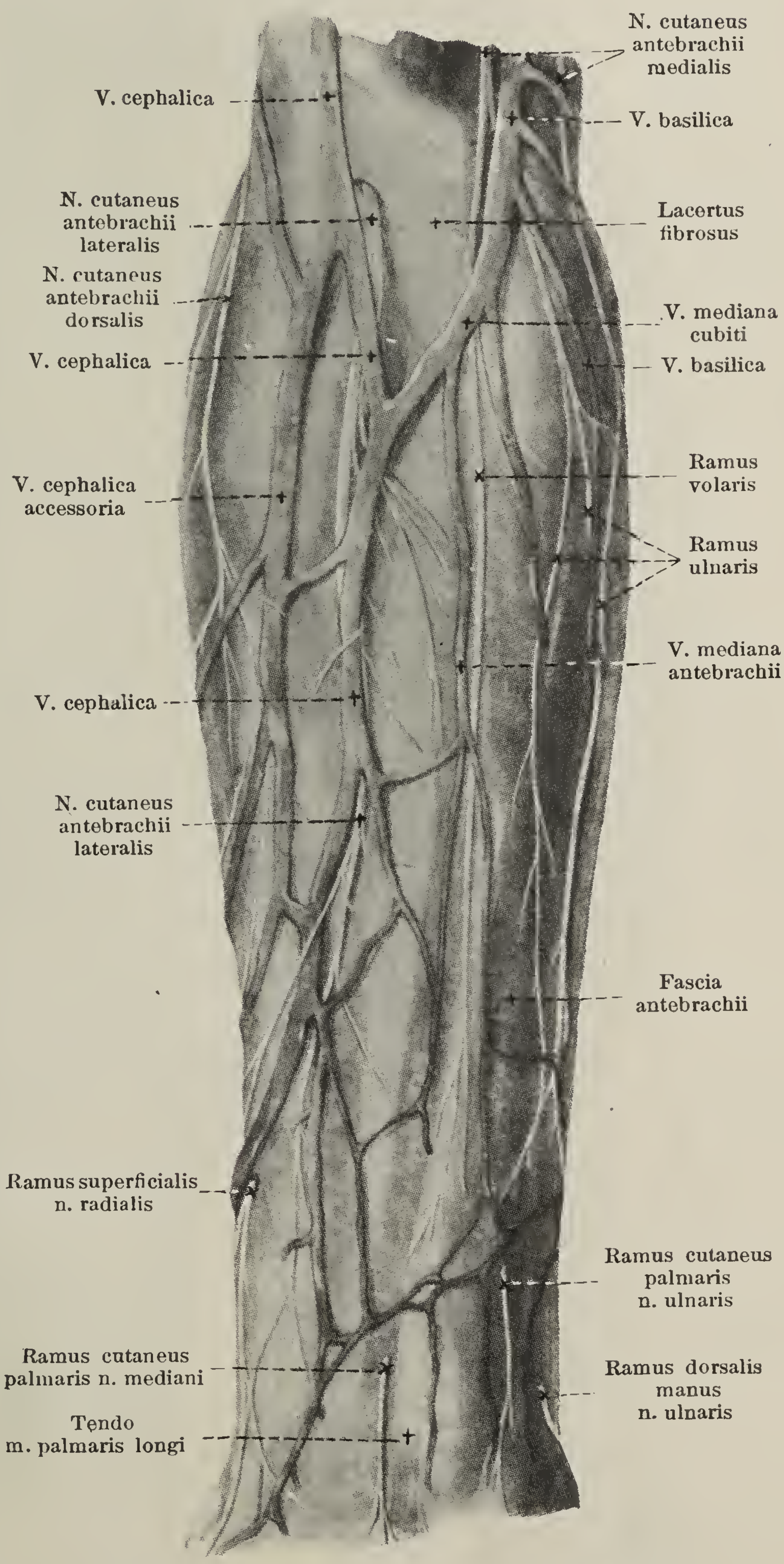
viewed from in front.

(The arm has been abducted; the fascia has been preserved throughout.)

1. *N. cutaneus brachii medialis* (O. T. lesser internal cutaneous) (see also Figs. 844, 849, 864, 865 and 869), from (C_8) Th_1, runs downward in the axillary fossa, in front of the mm. subscapularis and latissimus dorsi, at first dorsal, and then medial from the v. axillaris, and unites here in a very variable manner with the n. intercostobrachialis (see p. 766) of the second, sometimes also with that of the third intercostal nerve. The branches of these stems or their anastomoses perforate the fascia axillaris or fascia brachii in different places; they supply the skin of the axillary fossa and of the medial surface of the upper arm as far as the elbow joint, in addition a proximal portion of the anterior surface and a distal portion of the posterior surface.

2. *N. cutaneus antebrachii medialis* (O. T. internal cutaneous) (see also Figs. 844, 849, 851—854, 864 and 865), from C_8 and Th_1, lies on the anterior medial side of the v. axillaris and passes distalward near it; it perforates the fascia brachii in the middle of the upper arm or somewhat lower, usually at the point where the v. basilica vanishes under the fascia into the depth, and then (or previously) divides into two branches, which lie upon the fascia antebrachii.

851. Cutaneous nerves of the right forearm, volar surface. (The fasciae brachii and antebrachii have been preserved.)


N. cutaneus antebrachii medialis
V. cephalica
V. basilica
N. cutaneus antebrachii lateralis
Lacertus fibrosus
N. cutaneus antebrachii dorsalis
V. mediana cubiti
V. cephalica
V. basilica
Ramus volaris
V. cephalica accessoria
Ramus ulnaris
V. mediana antebrachii
V. cephalica
N. cutaneus antebrachii lateralis
Fascia antebrachii
Ramus superficialis n. radialis
Ramus cutaneus palmaris n. ulnaris
Ramus cutaneus palmaris n. mediani
Ramus dorsalis manus n. ulnaris
Tendo m. palmaris longi

2. *N. cutaneus antebrachii medialis* (continued) (see also Figs. 850, 852, 853, 864 and 865).

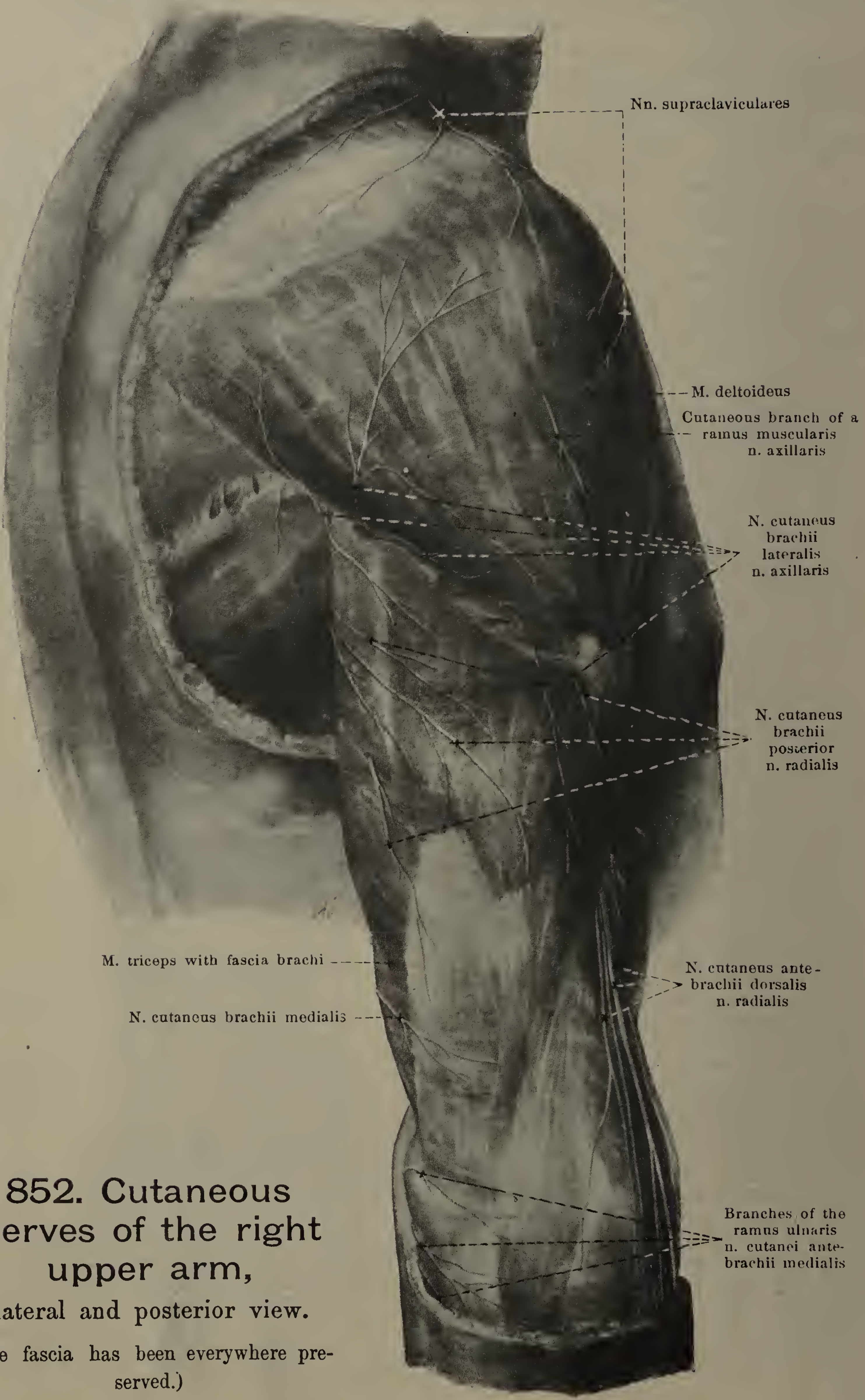
α) *Ramus volaris* (from Th_1) runs downward at first in front of the lacertus fibrosus, lateral from the v. basilica, then crosses it, usually on its posterior surface, and is distributed to the ulnar half of the volar surface of the forearm as far as the eminence of the little finger. It anastomoses in the forearm with branches of the n. cutaneus antebrachii lateralis and of the ramus cutaneus palmaris n. ulnaris.

β) *Ramus ulnaris* (from C_8), smaller, passes over the epicondylus to the ulnar margin of the forearm and along this almost as far as the region of the capitulum ulnae. It sends its branches to the skin of the ulnar half of the dorsal surface of the forearm and anastomoses in the forearm with branches of the n. cutaneus antebrachii dorsalis and of the ramus dorsalis manus n. ulnaris.

3. *N. musculocutaneus* (see also Figs. 844, 849, 850, 853 to 855 and 864–866), from C_5, C_6 (C_7), behaves like a branch of the n. medianus. It runs distalward, at first lateral and dorsal from the n. medianus and from the a. axillaris, perforates obliquely the substance of the m. coracobrachialis, passes distalward and lateralward between the m. biceps brachii and m. brachialis, to finally perforate the fascia brachii with its terminal branch, the *n. cutaneus antebrachii lateralis,* close above the elbow lateral from the tendon of insertion of the m. biceps, medial from and behind the v. cephalica. In about one third of the cases it anastomoses in the upper arm (see Fig. 855) with the n. medianus by a branch which is usually directed distalward toward the latter. It gives off:

a) *Rami musculares* (see Fig. 855) to the mm. coracobrachialis (C6, C7) (from the first part of the nerve), biceps (C_5, C_6 [C_7]) and brachialis (C_5, C_6 [C_7]).

b) *N. cutaneus antebrachii lateralis,* (see also Figs. 853, 860 and 864—866) from C_5 and C_6, passes upon the fascia antebrachii near the v. cephalica distalward usually as far as the hand; it supplies the skin upon the radial margin and the radial half of the volar surface of the forearm, upon the ball of the thumb and upon the thumb region of the back of the hand, and anastomoses in the forearm with the n. cutaneus antebrachii medialis, in the hand with the ramus superficialis n. radialis and ramus dorsalis manus n. ulnaris.


Nn. supraclaviculares
M. deltoideus
Cutaneous branch of a ramus muscularis n. axillaris
N. cutaneus brachii lateralis n. axillaris
N. cutaneus brachii posterior n. radialis
M. triceps with fascia brachi
N. cutaneus brachii medialis
N. cutaneus antebrachii dorsalis n. radialis
Branches of the ramus ulnaris n. cutanei antebrachii medialis

852. Cutaneous nerves of the right upper arm,

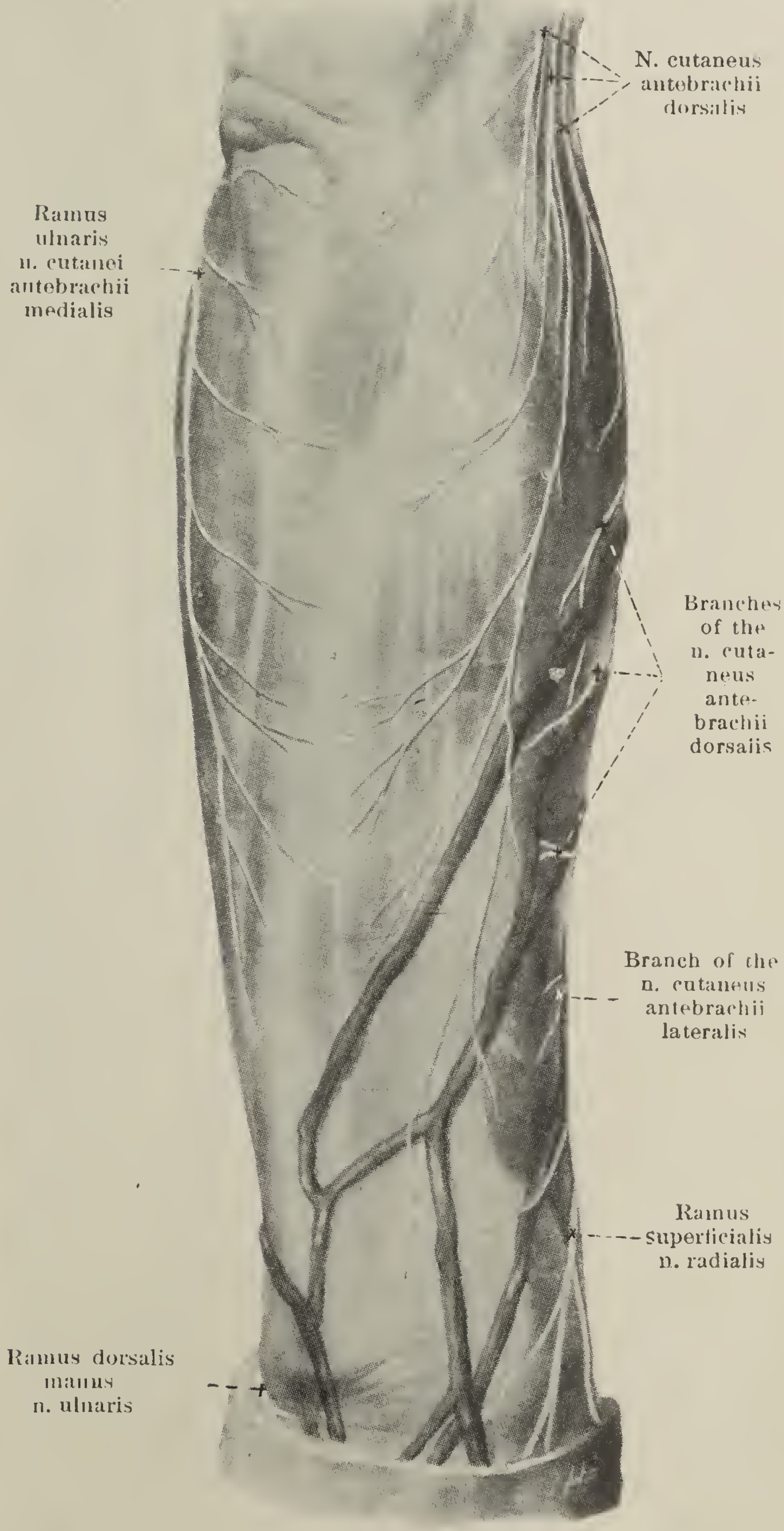
lateral and posterior view.

(The fascia has been everywhere preserved.)

853. Cutaneous nerves of the right forearm,

dorsal surface.

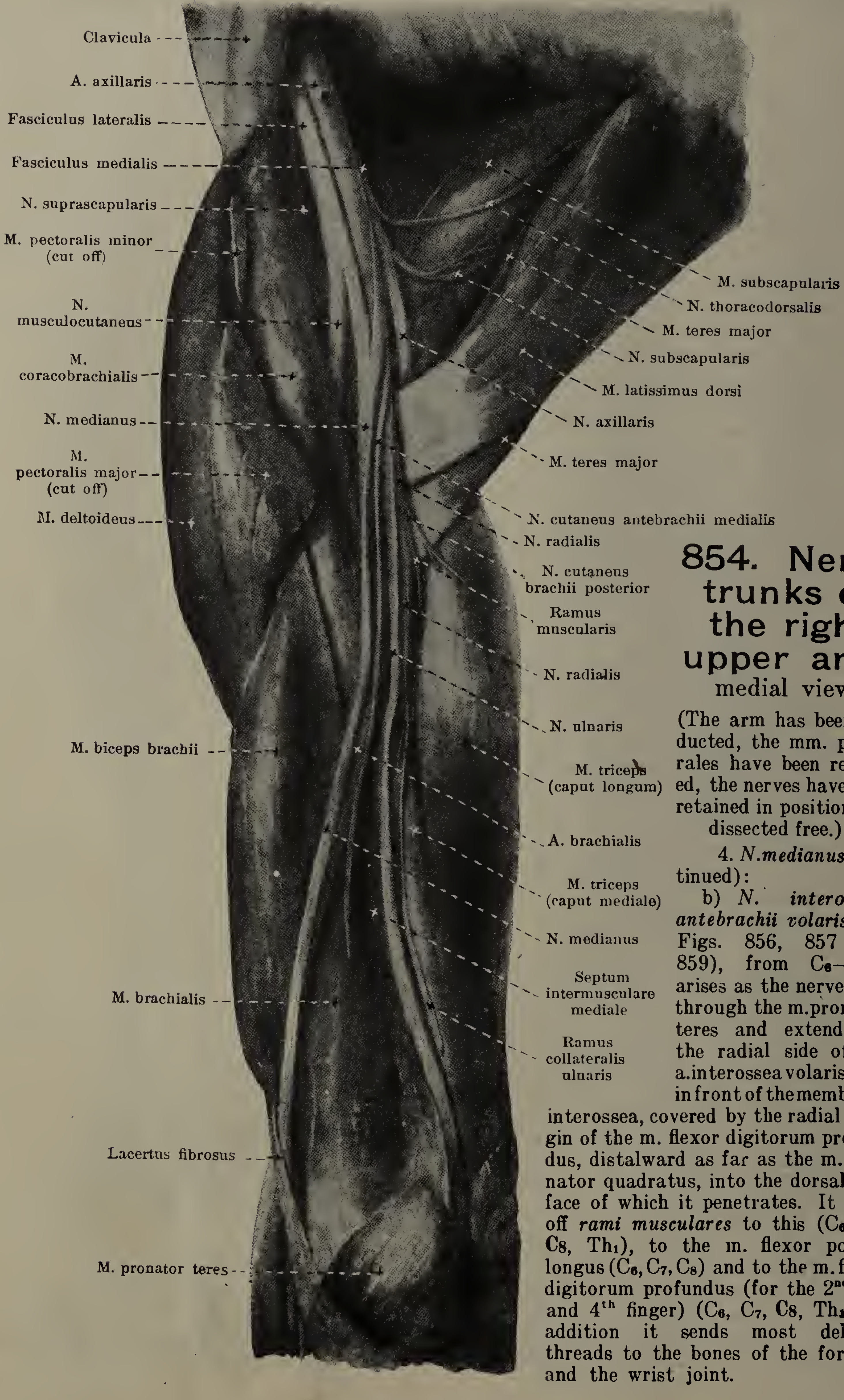
(The fasciae brachii and antebrachii have been preserved.)


N. cutaneus antebrachii dorsalis
Ramus ulnaris n. cutanei antebrachii medialis
Branches of the n. cutaneus antebrachii dorsalis
Branch of the n. cutaneus antebrachii lateralis
Ramus superficialis n. radialis
Ramus dorsalis manus n. ulnaris

4. *N. medianus* (see Figs. 844, 849, 851, 854—859, 861, 864 and 865) arises by two roots from the plexus, an upper (from C_5, C_6 and C_7) from the fasciculus lateralis and a lower (from C_8 and Th_1) from the fasciculus medialis. The two roots converging pass to the anterior lateral surface of the a. axillaris, where they combine. The nerve runs distalward with the a. brachialis, at first on the dorsal surface of the m. coracobrachialis, then in the sulcus bicipitalis medialis, and passes under the lacertus fibrosus upon the m. brachialis in the depth of the elbow; in its course it lies above on the anterior lateral side of the artery and then, above the elbow, gradually passes in front of it (rarely behind it) to its medial surface. In the forearm it passes in front of the a. ulnaris between the two heads of the m. pronator teres and below the tendinous arch of the m. flexor digitorum sublimis on the dorsal surface of the latter and extends to the wrist, approximately in the axis of the forearm, in the groove between the mm. flexor pollicis longus and flexor digitorum profundus along with the a. mediana (see also Fig. 507). Close above the wrist between and under the tendons of the mm. flexor carpi radialis and palmaris longus it approaches (see Fig. 856) again the surface under the fascia antebrachii. It then turns to the volar surface of the tendons of the mm. flexores digitorum and passes with these dorsal from the lig. carpi transversum in the canalis carpi to the hand (see Fig. 857). In the upper arm it receives in about one third of the cases a thick bundle from the n. musculocutaneus (see p. 749 and Fig. 855), and in the forearm it anastomoses by a fine thread with the n. ulnaris between the mm. flexores digitorum. It gives off no branches in the upper arm.

Branches in the forearm:

a) ***Rami musculares*** (see Figs. 855—857), go off at the level of the epicondylus medialis humeri to the m. pronator teres (usually two) (**C6**, C7) and through this to the mm. flexor carpi radialis (C6, **C7** [C8]), palmaris longus (C_7, C_8, Th_1) and flexor digitorum sublimis; as the trunk passes through the m. pronator teres still other branches arise for the m. flexor digitorum sublimis (all fibres from [C6, C7] **C8**, Th1).



854. Nerve trunks of the right upper arm, medial view.

(The arm has been abducted, the mm. pectorales have been removed, the nerves have been retained in position and dissected free.)

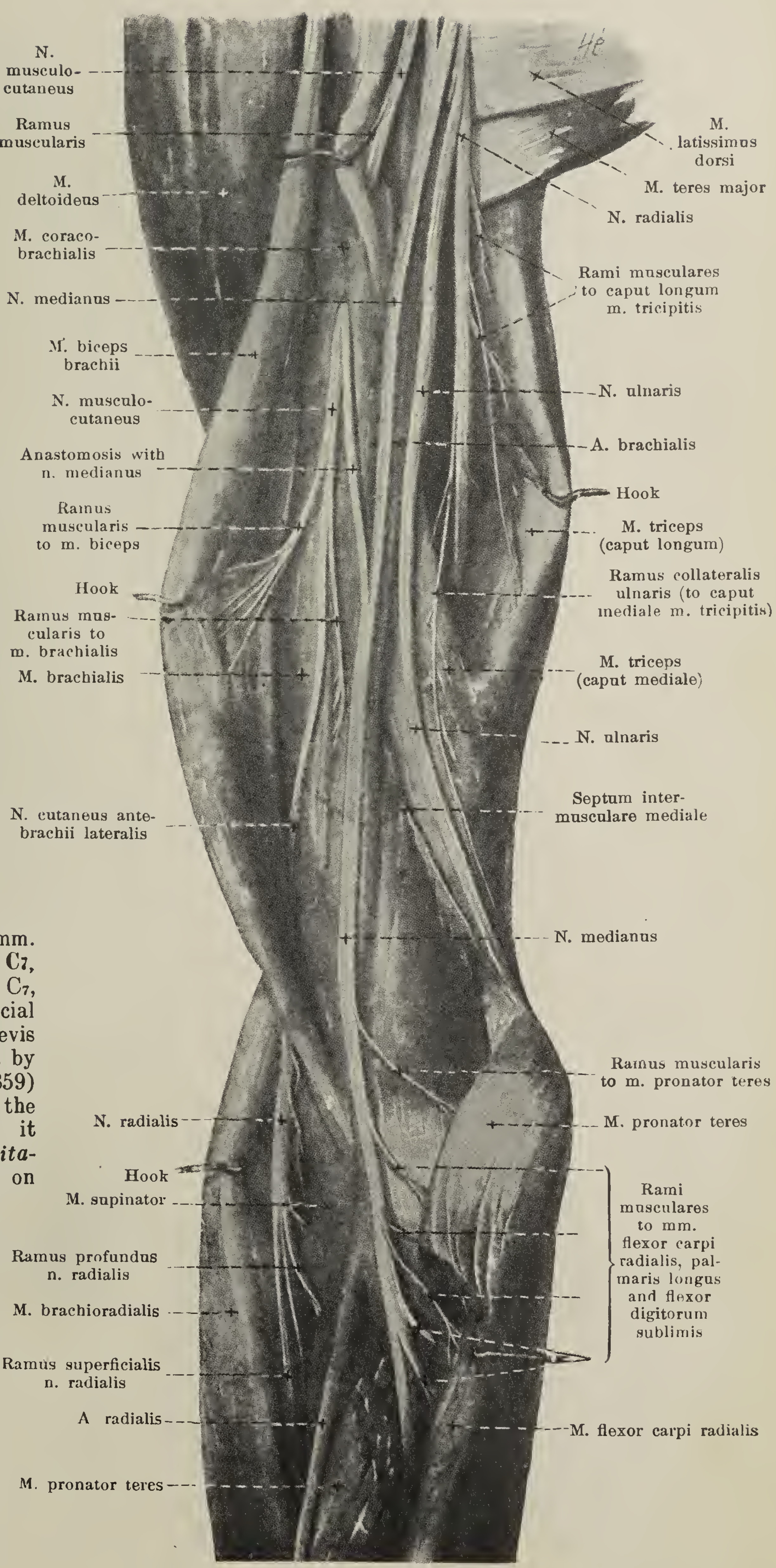
4. *N. medianus* (continued):

b) *N. interosseus antebrachii volaris* (see Figs. 856, 857 and 859), from C_6—Th_1, arises as the nerve goes through the m. pronator teres and extends on the radial side of the a. interossea volaris, just in front of the membrana interossea, covered by the radial margin of the m. flexor digitorum profundus, distalward as far as the m. pronator quadratus, into the dorsal surface of which it penetrates. It gives off *rami musculares* to this (C_6, C_7, C_8, Th_1), to the m. flexor pollicis longus (C_6, C_7, C_8) and to the m. flexor digitorum profundus (for the 2nd, 3rd and 4th finger) (C_6, C_7, C_8, Th_1); in addition it sends most delicate threads to the bones of the forearm and the wrist joint.

855. Muscle nerves of the right upper arm,

viewed from in front.

(The arm has been abducted; the mm. biceps, triceps and brachioradialis have been drawn aside; a piece has been cut out of the m. pronator teres.)

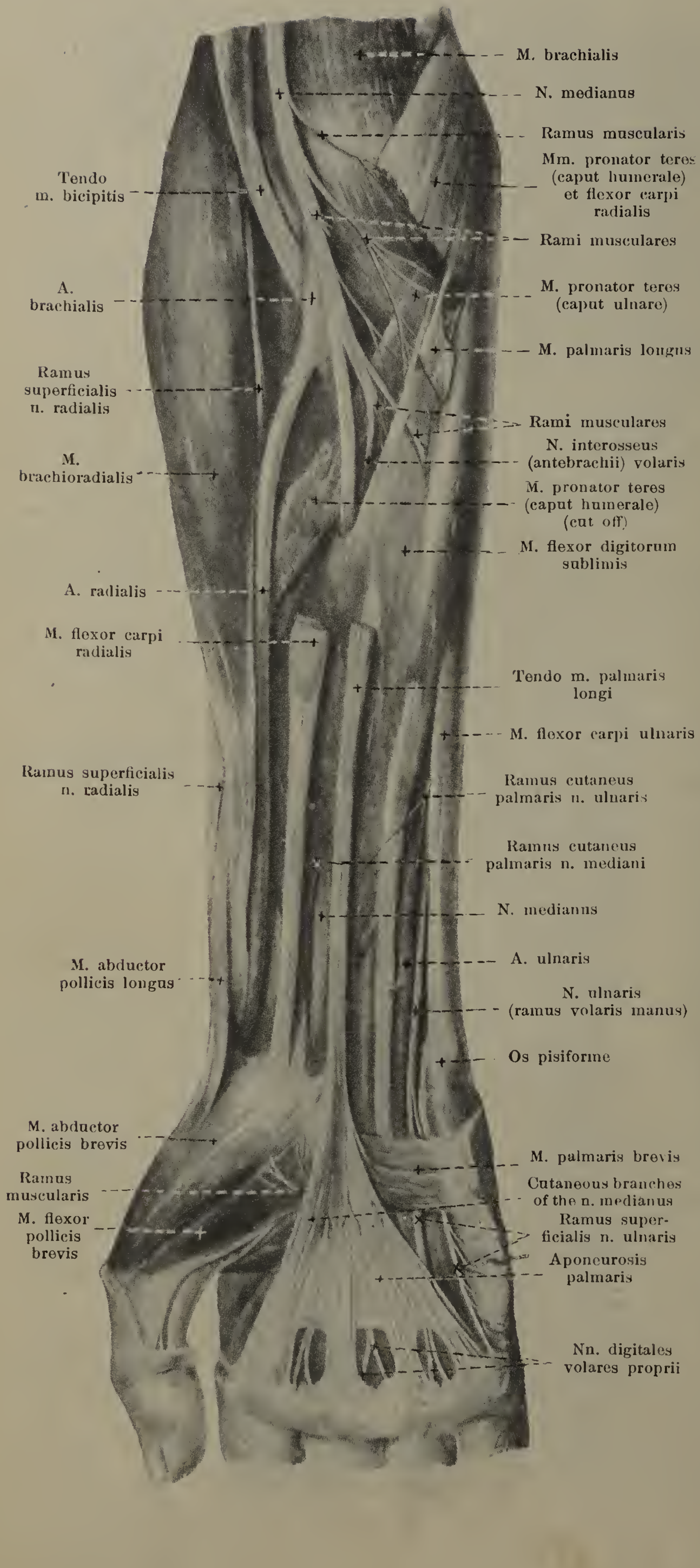

N. musculocutaneus
Ramus muscularis
M. deltoideus
M. coracobrachialis
N. medianus
M. biceps brachii
N. musculocutaneus
Anastomosis with n. medianus
Ramus muscularis to m. biceps
Hook
Ramus muscularis to m. brachialis
M. brachialis
N. cutaneus antebrachii lateralis
N. radialis
Hook
M. supinator
Ramus profundus n. radialis
M. brachioradialis
Ramus superficialis n. radialis
A radialis
M. pronator teres
M. latissimus dorsi
M. teres major
N. radialis
Rami musculares to caput longum m. tricipitis
N. ulnaris
A. brachialis
Hook
M. triceps (caput longum)
Ramus collateralis ulnaris (to caput mediale m. tricipitis)
M. triceps (caput mediale)
N. ulnaris
Septum intermusculare mediale
N. medianus
Ramus muscularis to m. pronator teres
M. pronator teres
Rami musculares to mm. flexor carpi radialis, palmaris longus and flexor digitorum sublimis
M. flexor carpi radialis

4. *N. medianus* (continued):

c) *Ramus cutaneus palmaris* (see Figs. 851, 856 and 864) arises at a variable level above the wrist, perforates the fascia between the mm. flexor carpi radialis and palmaris longus, and passes upon the fascia to the skin of the ball of the thumb and of the hollow of the hand.

Branches in the hand:

d) *N. digitales volares communes* (see Figs. 856 to 859, 861 and 864—867), three, pass in the 1st to the 3rd spatium interosseum metacarpi under the aponeurosis palmaris and the arcus volaris superficialis, diverging distalward. The first gives off a ***ramus muscularis*** to the mm. abductor pollicis brevis (C_6, C_7, [C_8]), opponens pollicis (C_6, C_7, [C_8, Th_1]) and to the superficial head of the m. flexor pollicis brevis (C_6, C_7, C_8) and anastomoses by a delicate branch (see Fig. 859) passing into the depth with the ramus profundus n. ulnaris; it then divides into three ***nn. digitales volares proprii,*** which run on the radial and ulnar margins of the volar surface of the thumb and on the radial margin of the volar surface of the index finger as far as the tips of the fingers; the first anastomose with the digital branches of the n. radialis, the last usually sends cutaneous branches to the back of the finger (see Figs. 858 and 861) and a muscular branch to the m. lumbricalis I (C_7, C_8, Th_1) (see Fig. 858).


M. brachialis
N. medianus
Ramus muscularis
Mm. pronator teres (caput humerale) et flexor carpi radialis
Rami musculares
M. pronator teres (caput ulnare)
M. palmaris longus
Rami musculares
N. interosseus (antebrachii) volaris
M. pronator teres (caput humerale) (cut off)
M. flexor digitorum sublimis
Tendo m. palmaris longi
M. flexor carpi ulnaris
Ramus cutaneus palmaris n. ulnaris
Ramus cutaneus palmaris n. mediani
N. medianus
A. ulnaris
N. ulnaris (ramus volaris manus)
Os pisiforme
M. palmaris brevis
Cutaneous branches of the n. medianus
Ramus superficialis n. ulnaris
Aponeurosis palmaris
Nn. digitales volares proprii
Tendo m. bicipitis
A. brachialis
Ramus superficialis n. radialis
M. brachioradialis
A. radialis
M. flexor carpi radialis
Ramus superficialis n. radialis
M. abductor pollicis longus
M. abductor pollicis brevis
Ramus muscularis
M. flexor pollicis brevis

856. Nerves of the right forearm,

viewed from in front, more superficial layer.

(The caput humerale of the m. pronator teres, as well as the muscular bellies of the mm. flexor carpi radialis and palmaris longus have been in large part removed.)

4. *N. medianus* (continued): d) *Nn. digitales volares communes:*

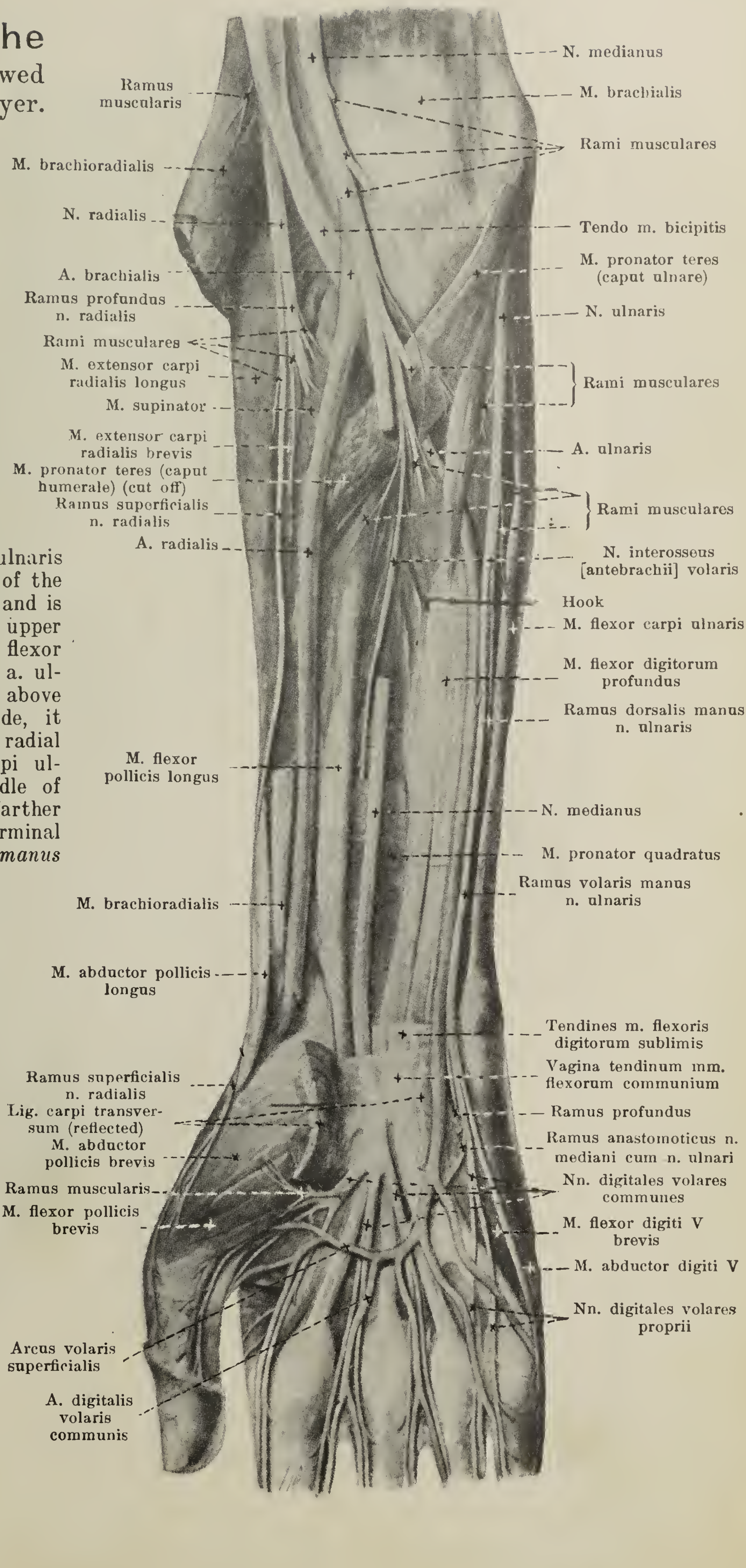
The second and the third n. digitalis volaris communis (see Figs. 857, 858 and 864—867) send a twig to the mm. lumbricales II and (often) III (C_7, C_8, Th_1); each divides into two ***nn. digitales volares proprii*** for the adjacent margins of the 2nd, 3rd and 4th finger, which usually supply also the dorsal surfaces of their second and third phalanges. The third unites in a variable manner by means of a ***ramus anastomoticus cum n. ulnari*** with the ramus superficialis n. ulnaris (see Figs. 857 and 858).

The nn. digitales volares communes send delicate branches through the aponeurosis palmaris to the skin of the palm. In the region of the fingers numerous small ***corpuscula lamellosa [Vateri, Pacini]*** (see Fig. 858) are to be found; they are united with the nerves by small twigs.

5. ***N. ulnaris*** (see Figs. 844, 849, 851, 854—860 and 864 to 867), from C_7, C_8 and Th_1, passes distalward at first on the posterior medial surface of the aa. axillaris and brachialis in front of the n. radialis, m. latissimus dorsi and caput longum m. tricipitis, and then runs superficially downward, covered only by the fascia brachii, on the anterior medial surface of the caput mediale m. tricipitis behind the septum intermusculare mediale, gradually becoming separated from the a. brachialis, to the sulcus n. ulnaris of the humerus.

857. Nerves of the right forearm, viewed from in front, deeper layer.

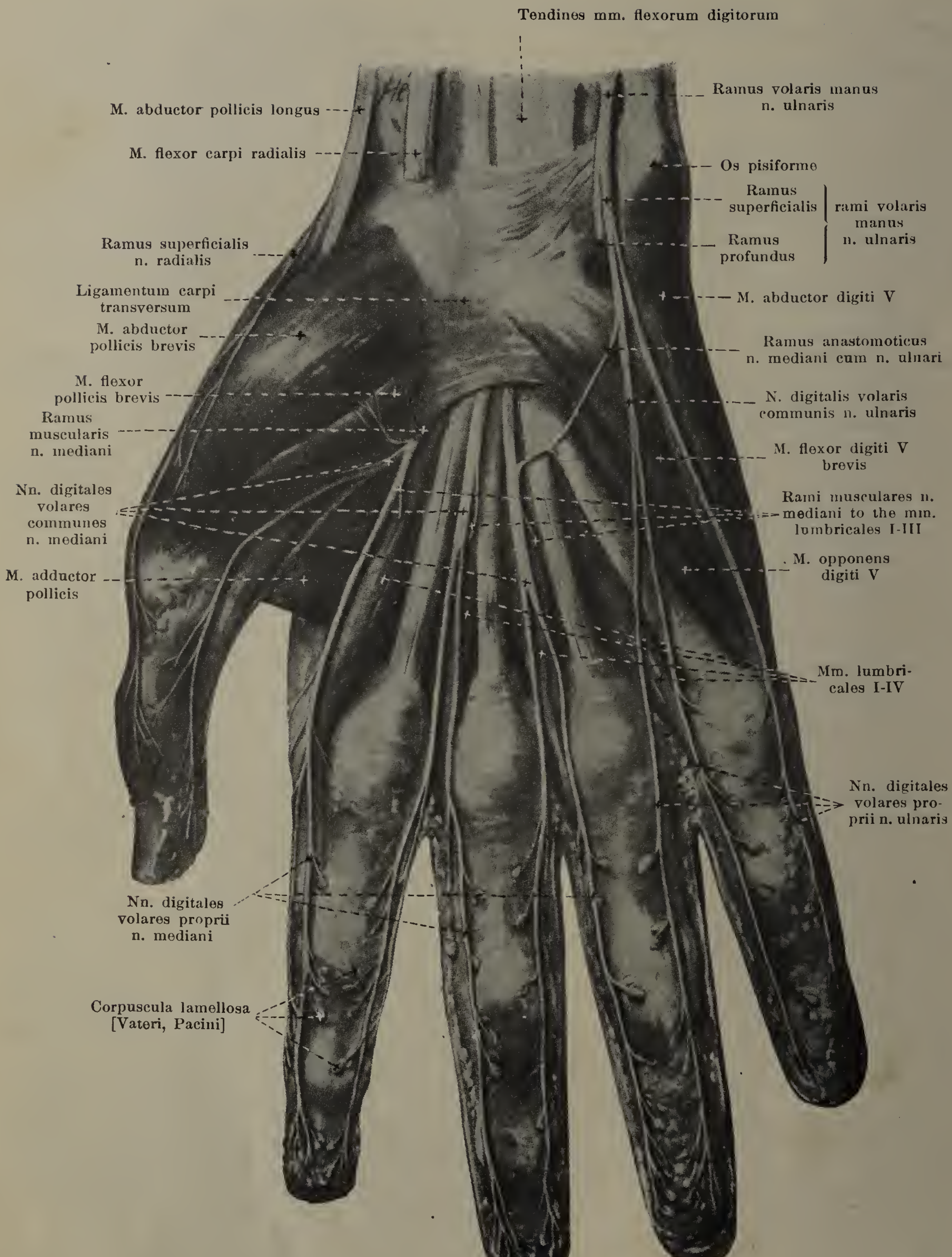
(The caput humerale of the m. pronator teres, as well as the mm. brachioradialis, flexor carpi radialis, palmaris longus and flexor digitorum sublimis have been removed; the lig. carpi transversum has been cut through and reflected.)


N. medianus
Ramus muscularis
M. brachialis
Rami musculares
M. brachioradialis
N. radialis
Tendo m. bicipitis
A. brachialis
M. pronator teres (caput ulnare)
Ramus profundus n. radialis
N. ulnaris
Rami musculares
M. extensor carpi radialis longus
Rami musculares
M. supinator
M. extensor carpi radialis brevis
A. ulnaris
M. pronator teres (caput humerale) (cut off)
Ramus superficialis n. radialis
Rami musculares
A. radialis
N. interosseus [antebrachii] volaris
Hook
M. flexor carpi ulnaris
M. flexor digitorum profundus
Ramus dorsalis manus n. ulnaris
M. flexor pollicis longus
N. medianus
M. pronator quadratus
Ramus volaris manus n. ulnaris
M. brachioradialis
M. abductor pollicis longus
Tendines m. flexoris digitorum sublimis
Ramus superficialis n. radialis
Vagina tendinum mm. flexorum communium
Lig. carpi transversum (reflected)
Ramus profundus
M. abductor pollicis brevis
Ramus anastomoticus n. mediani cum n. ulnari
Ramus muscularis
Nn. digitales volares communes
M. flexor pollicis brevis
M. flexor digiti V brevis
M. abductor digiti V
Nn. digitales volares proprii
Arcus volaris superficialis
A. digitalis volaris communis

5. *N. ulnaris* (see also Figs. 851, 856, 858—860 and 864—867) (continued): In the sulcus n. ulnaris of the humerus it lies between the epicondylus medialis humeri and the olecranon ulnae directly upon the bone. Thence it passes between the two heads of the m. flexor carpi ulnaris on its radial surface in front of the m. flexor digitorum profundus and is accordingly covered in the upper half of the forearm by the m. flexor digitorum sublimis. Near the a. ulnaris, which comes, somewhat above the middle, on its radial side, it passes next distalward on the radial margin of the m. flexor carpi ulnaris and divides in the middle of the foramen or somewhat farther distalward into its two terminal branches, the ***ramus dorsalis manus*** and the ***ramus volaris manus.*** It gives off no branches in the upper arm; in the forearm it anastomoses by a delicate branch with the n. medianus (see p. 751) and sends off the following branches:

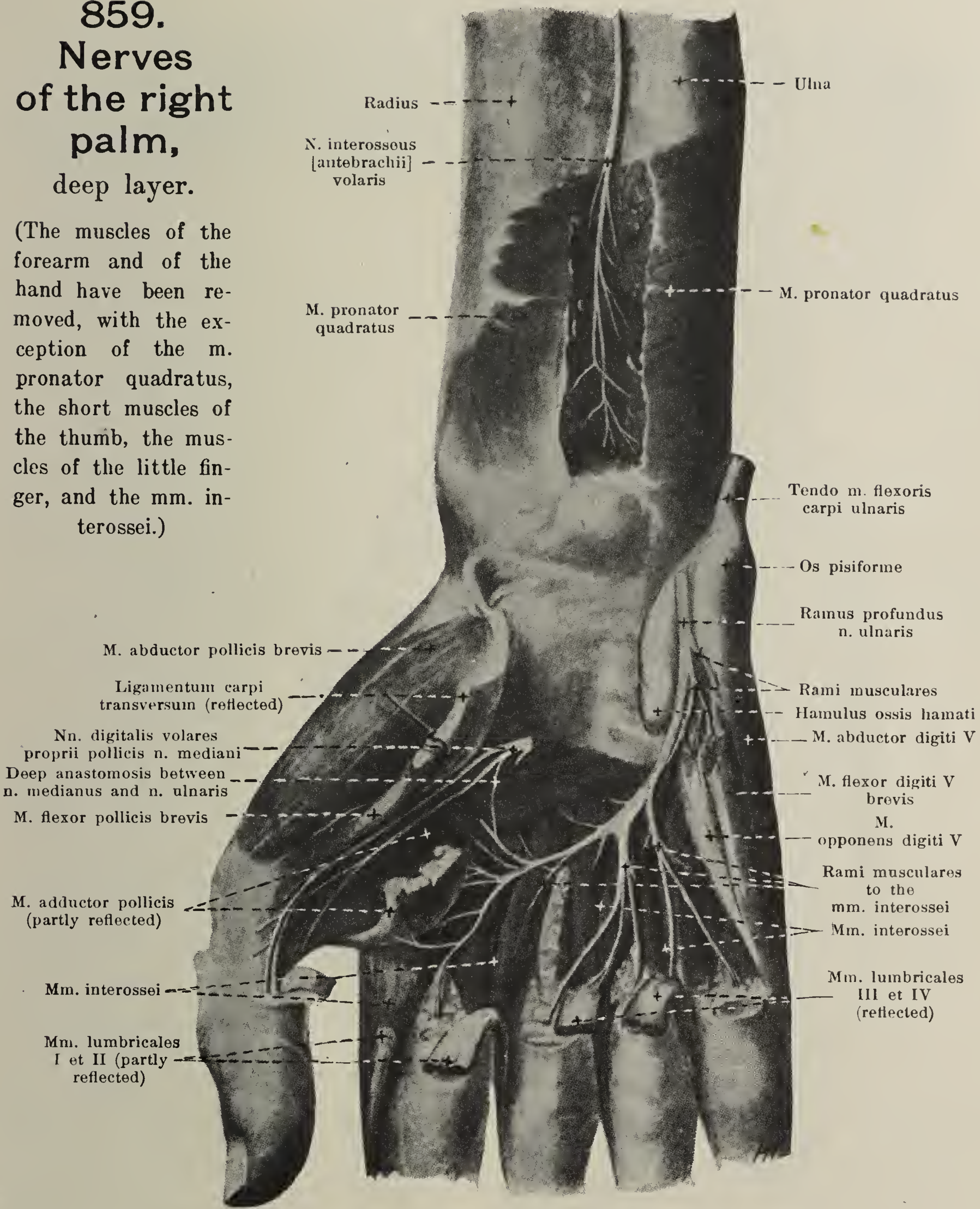
a) ***Rami musculares*** to the m. flexor carpi ulnaris (C_8, Th_1) and to the m. flexor digitorum profundus (to the 3rd, 4th and 5th finger) (C_8, Th_1).

b) ***Ramus cutaneus palmaris*** (see also Figs. 851, 856 and 864), delicate, arises in the middle of the forearm or more proximalward, accompanies the a. ulnaris as far as the hand and in the forearm sends a twig through the fascia distalward to the skin of the volar surface of the wrist and of the ball of the little finger; this twig anastomoses with the n. cutaneus antebrachii medialis.


Tendines mm. flexorum digitorum
M. abductor pollicis longus
M. flexor carpi radialis
Ramus volaris manus n. ulnaris
Os pisiforme
Ramus superficialis
Ramus profundus
rami volaris manus n. ulnaris
Ramus superficialis n. radialis
Ligamentum carpi transversum
M. abductor pollicis brevis
M. abductor digiti V
Ramus anastomoticus n. mediani cum n. ulnari
M. flexor pollicis brevis
Ramus muscularis n. mediani
N. digitalis volaris communis n. ulnaris
M. flexor digiti V brevis
Nn. digitales volares communes n. mediani
Rami musculares n. mediani to the mm. lumbricales I-III
M. adductor pollicis
M. opponens digiti V
Mm. lumbricales I-IV
Nn. digitales volares proprii n. ulnaris
Nn. digitales volares proprii n. mediani
Corpuscula lamellosa [Vateri, Pacini]

858. Nerves of the right palm, superficial layer.

(The fascia antebrachii and the aponeurosis palmaris have been removed.)

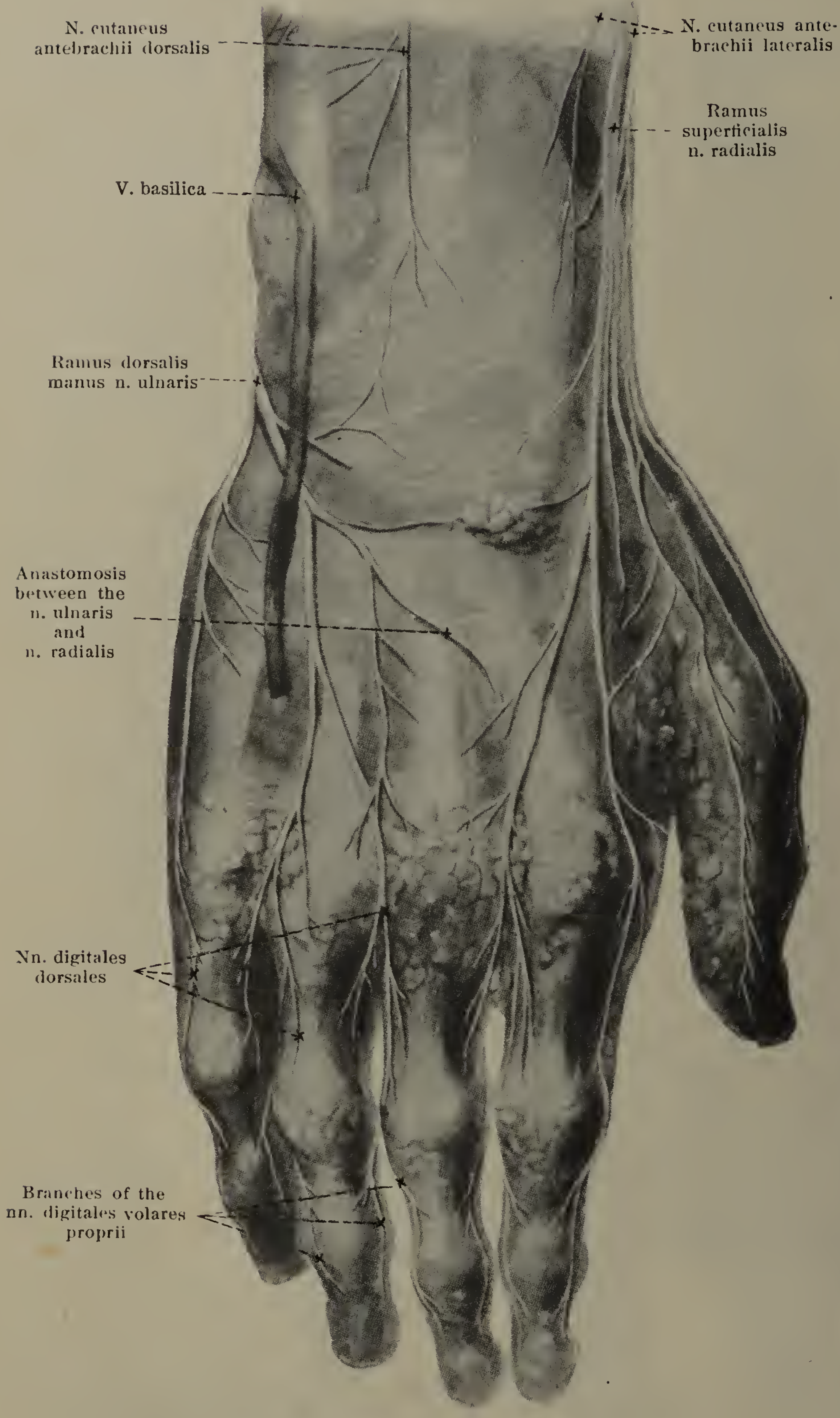

Radius
N. interosseus [antebrachii] volaris
M. pronator quadratus
Ulna
M. pronator quadratus
Tendo m. flexoris carpi ulnaris
Os pisiforme
Ramus profundus n. ulnaris
M. abductor pollicis brevis
Ligamentum carpi transversum (reflected)
Nn. digitalis volares proprii pollicis n. mediani
Deep anastomosis between n. medianus and n. ulnaris
M. flexor pollicis brevis
M. adductor pollicis (partly reflected)
Mm. interossei
Mm. lumbricales I et II (partly reflected)
Rami musculares
Hamulus ossis hamati
M. abductor digiti V
M. flexor digiti V brevis
M. opponens digiti V
Rami musculares to the mm. interossei
Mm. interossei
Mm. lumbricales III et IV (reflected)

859. Nerves of the right palm, deep layer.

(The muscles of the forearm and of the hand have been removed, with the exception of the m. pronator quadratus, the short muscles of the thumb, the muscles of the little finger, and the mm. interossei.)

5. *N. ulnaris* (continued):

c) ***Ramus dorsalis manus*** (see Figs. 853, 857, 860 and 864—867), one terminal branch, usually the smaller, passes along the ulna, between it and the tendon of the m. flexor carpi ulnaris, distalward upon the dorsal surface of the capitulum ulnae. There it perforates the fascia antebrachii and divides upon the lig. carpi dorsale. It sends delicate branches radialward, which anastomose with branches of the nn. cutanei antebrachii medialis, dorsalis and lateralis and of the ramus superficialis n. radialis, and 5 ***nn. digitales dorsales*** distalward, which run along the ulnar margin of the 5th, 4th and 3rd finger, and the radial margin of the 5th and 4th finger, reaching constantly to the base of the nail on the 5th finger, but on the 4th finger usually and on the 3rd finger almost constantly not going beyond the first phalanx.


N. cutaneus antebrachii dorsalis
N. cutaneus antebrachii lateralis
Ramus superficialis n. radialis
V. basilica
Ramus dorsalis manus n. ulnaris
Anastomosis between the n. ulnaris and n. radialis
Nn. digitales dorsales
Branches of the nn. digitales volares proprii

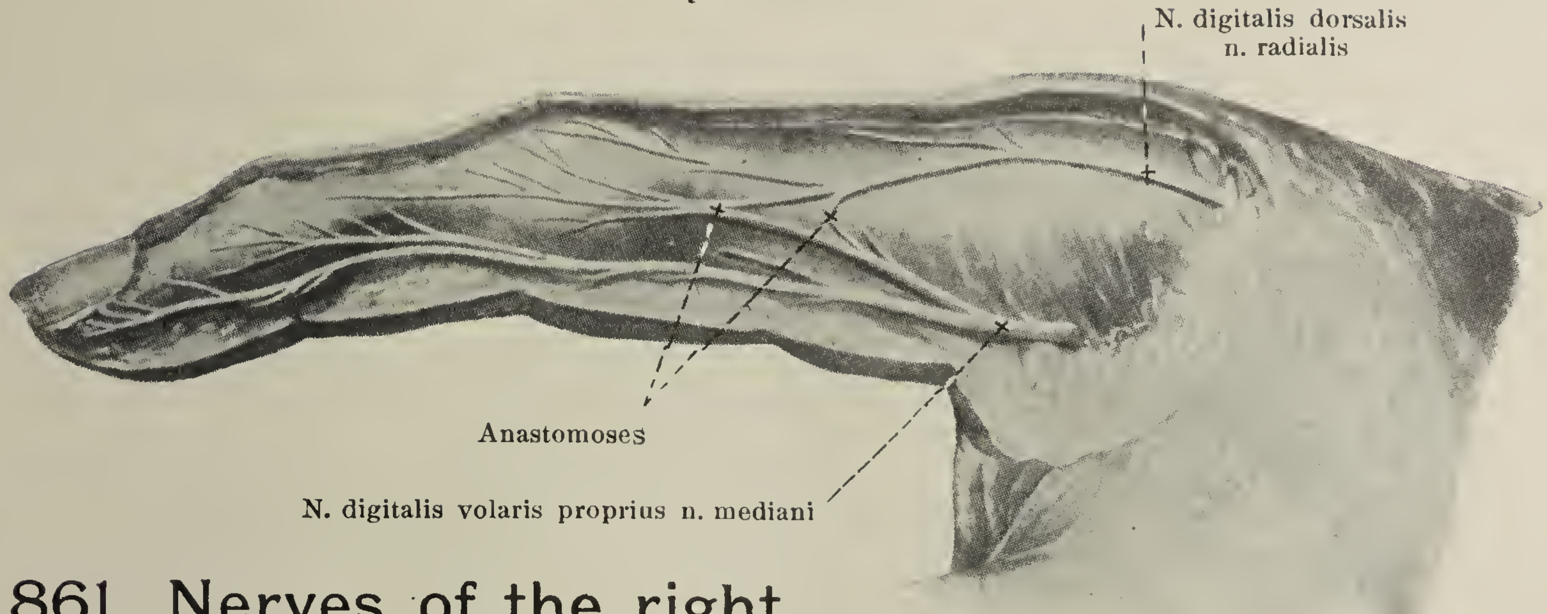
860. Nerves of the dorsum of the right hand.

(The fascia has been everywhere preserved; the veins have been in large part removed.)

5. *N. ulnaris* (continued):

d) ***Ramus volaris manus*** (see Figs. 856 to 859 and 864), the second terminal branch, runs in the direction of the stem on the ulnar side of the a. ulnaris and at the radial margin of the m. flexor carpi ulnaris, between this and the m. flexor digitorum sublimis, covered only by the fascia antebrachii and the lig. carpi volare, to the hand, and there divides in front of the lig. carpi transversum on the radial side of the os pisiforme into the ***ramus superficialis*** and ***ramus profundus***.

α) ***Ramus superficialis*** (see Figs. 856 to 858 and 864) gives off at first a fine ***ramus muscularis*** to the m. palmaris brevis ([C_7], C_8, [Th_1]) and an anastomosing branch to the n. medianus (see p. 754). It then divides into a ***n. digitalis volaris proprius,*** which runs distalward upon the muscles of the ball of the little finger to the ulnar margin of the volar surface of the 5th finger, and into a ***n. digitalis volaris communis,*** which runs distalward just beneath the aponeurosis palmaris, upon the fourth spatium interosseum metacarpi, and divides into two ***nn. digitales volares proprii,*** for the adjacent margins of the volar surfaces of the 4th and 5th finger, that for the 4th finger usually supplying also the dorsal surface of the 2nd and 3rd phalanx. They are connected with small *corpuscula lamellosa [Vateri, Pacini]* (see p. 754).


N. digitalis dorsalis n. radialis
Anastomoses
N. digitalis volaris proprius n. mediani

861. Nerves of the right index finger,

viewed from the radial side.

5. *N. ulnaris* (continued): d) *Ramus volaris manus:*

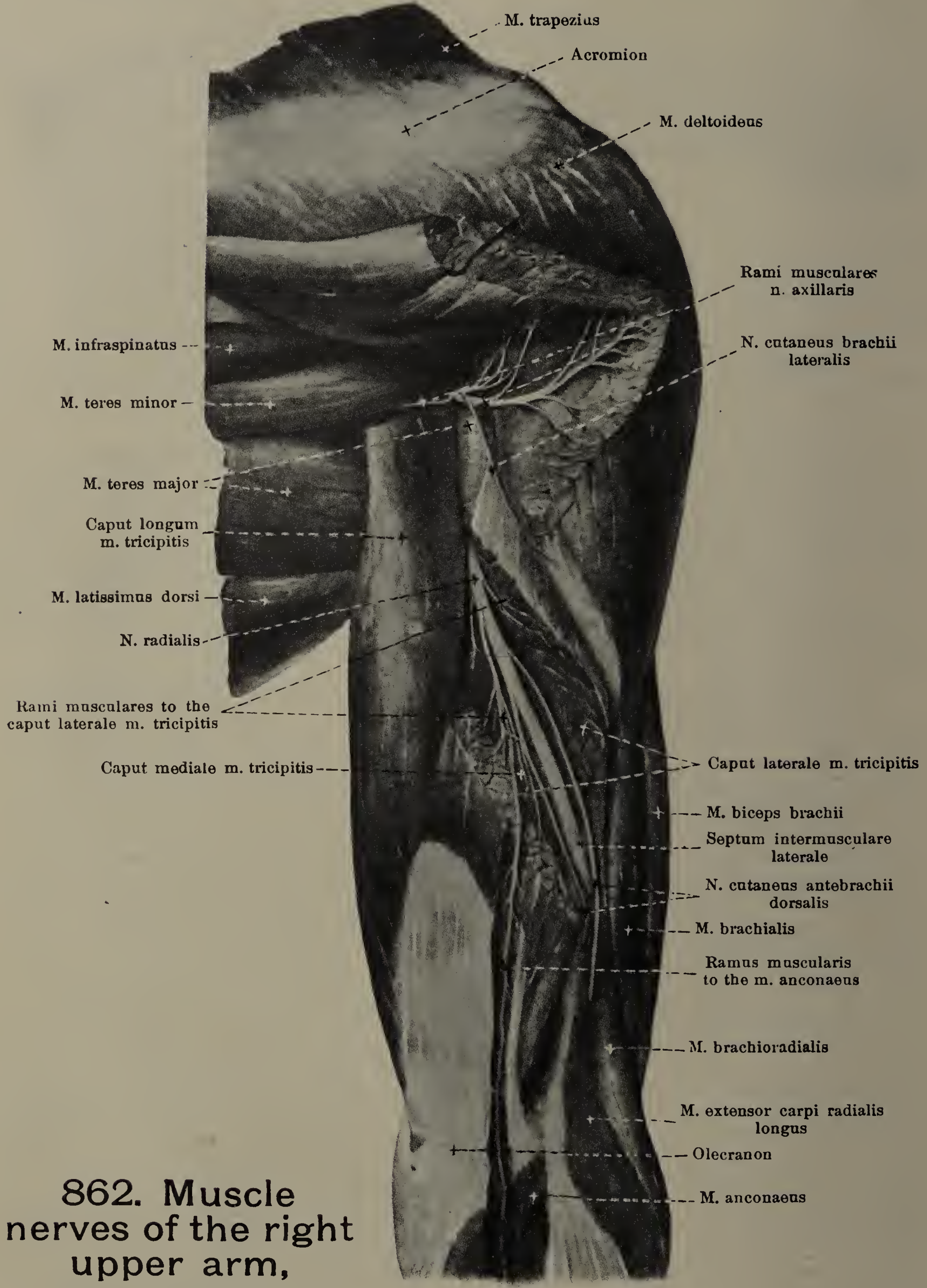
β) *Ramus profundus* (see Figs. 858 and 859) with the ramus volaris profundus a. ulnaris bends into the depth between the origins of the mm. abducor digiti V and flexor digiti V brevis through the origin of the m. opponens digiti V and at the same time in a curve radialward around the hamulus ossis hamati; it then lies upon the volar surface of the mm. interossei, crosses the arcus volaris profundus and ends in a delicate anastomosis with the n. medianus (see p. 753). It gives off *rami musculares* at its beginning to the short muscles of the little finger ([C_7], C_8 [Th_1]), in the depth to the mm. interossei ([C_7] C_8, Th_1), the mm. lumbricales IV and (often) III (C_7, C_8, Th_1), the m. adductor pollicis (C_7, C_8, Th_1) and the deep head of the m. flexor pollicis brevis (C6, **C7**, C8), in addition branches to the joints and bones of the hand.

6. *N. radiales* (O.T. musculospiral nerve) (see also Figs. 844, 851—858, 860 and 862—867), from C_5, C_6, C_7, C_8 and Th_1, passes distalward behind the n. ulnaris and the a. axillaris in front of the m. subscapularis and the tendons of the mm. latissimus dorsi and teres major (see Figs. 854 and 855), and lateral from the caput longum m. tricipitis bends behind the artery, and then on the dorsal surface of the humerus in its sulcus n. radialis, covered by the caput laterale of the m. triceps, runs distalward and lateralward in a long drawn-out spiral (see Figs. 402 and 862); in its course it lies at first near the a. profunda brachii, then near the a. collateralis radialis (see also Fig. 505). At the junction of the middle and lower thirds of the humerus it perforates the septum intermusculare laterale and the origin of the m. brachioradialis (see Figs. 402, 404 and 862) and on the medial surface of the latter arrives in the groove between the m. brachioradialis and the m. brachialis; in this it lies behind on some bundles of the latter and passes distalward near the a. recurrens radialis, to divide in front of the capitulum radii or somewhat higher up into the *ramus profundus* and *ramus superficialis* (see Figs. 855, 857 and 863). Before dividing it gives off the following branches:

a) *N. cutaneus brachii posterior* (see Figs. 852, 854 and 865) (C_7, C_8) arises, often along with a muscular branch for the caput longum m. tricipitis, at the lower margin of the fossa axillaris in front of the tendon of the m. teres major, then runs in front of the caput longum of the m. triceps and around its medial margin obliquely curved upon its posterior surface, there perforates the fascia brachii and branches in the skin of the back of the upper arm, about over the caput laterale and mediale of the m. triceps. It anastomoses with branches of the n. cutaneus brachii lateralis.

b) *Rami musculares* (see Figs. 854, 855 and 862), to the three heads of the m. triceps (C6, **C7**, **C8** |Th1]); the branch for the caput mediale, *ramus collateralis ulnaris* (see Figs. 854 and 855), runs for some distance superficially, just behind the n. ulnaris distalward, and a long branch passes first in the caput laterale (see Fig. 862), then in the caput mediale between the olecranon and the epicondylus lateralis humeri downward to the m. anconaeus ([C6], **C7**, C8 [Th1]).

c) *N. cutaneus antebrachii dorsalis* (see Figs. 851—853, 860, 862 and 864—867) (C_6, C_7, C_8 [Th_1]) arises (see Fig. 862) in the sulcus n. radialis in front of the caput laterale of the m. triceps, passes in front of it lateralward and downward near the n. radialis, and lateral from this muscle perforates the fascia brachii (see Fig. 852), between the insertion of the m. deltoideus and the epicondylus lateralis humeri, behind the septum intermusculare laterale and the v. cephalica. There it divides into several branches and passes distalward to the skin of the radial part of the elbow and to the dorsal surface of the forearm as far as the proximal part of the back of the hand. In its course it anastomoses with the branches of the nn. cutanei brachii lateralis and antebrachii medialis, as well as with the ramus dorsalis manus n. ulnaris and the ramus superficialis n. radialis.


M. trapezius
Acromion
M. deltoideus
Rami musculares n. axillaris
N. cutaneus brachii lateralis
M. infraspinatus
M. teres minor
M. teres major
Caput longum m. tricipitis
M. latissimus dorsi
N. radialis
Rami musculares to the caput laterale m. tricipitis
Caput mediale m. tricipitis
Caput laterale m. tricipitis
M. biceps brachii
Septum intermusculare laterale
N. cutaneus antebrachii dorsalis
M. brachialis
Ramus muscularis to the m. anconaeus
M. brachioradialis
M. extensor carpi radialis longus
Olecranon
M. anconaeus

862. Muscle nerves of the right upper arm, viewed from behind.

(Pieces have been cut out of the m. deltoideus, caput laterale m. tricipitis and m. anconaeus.)

6. *N. radialis* (continued):

d) *Rami musculares*, after perforating the septum intermusculare laterale (see Figs. 855, 857 and 863), go to the mm. brachioradialis (C_5, C_6), extensor carpi radialis longus ([C_5] C_6, C_7, C_8); often a delicate thread also to the lateral part of the m. brachialis (C_5, C_6).

863. Muscle nerves of the right forearm,

viewed from behind and lateralward.

(The mm. brachioradialis, extensores carpi radialis and digitorum communis have been cut through and reflected dorsalward and ulnarward. A piece has been cut out of the m. supinator.)

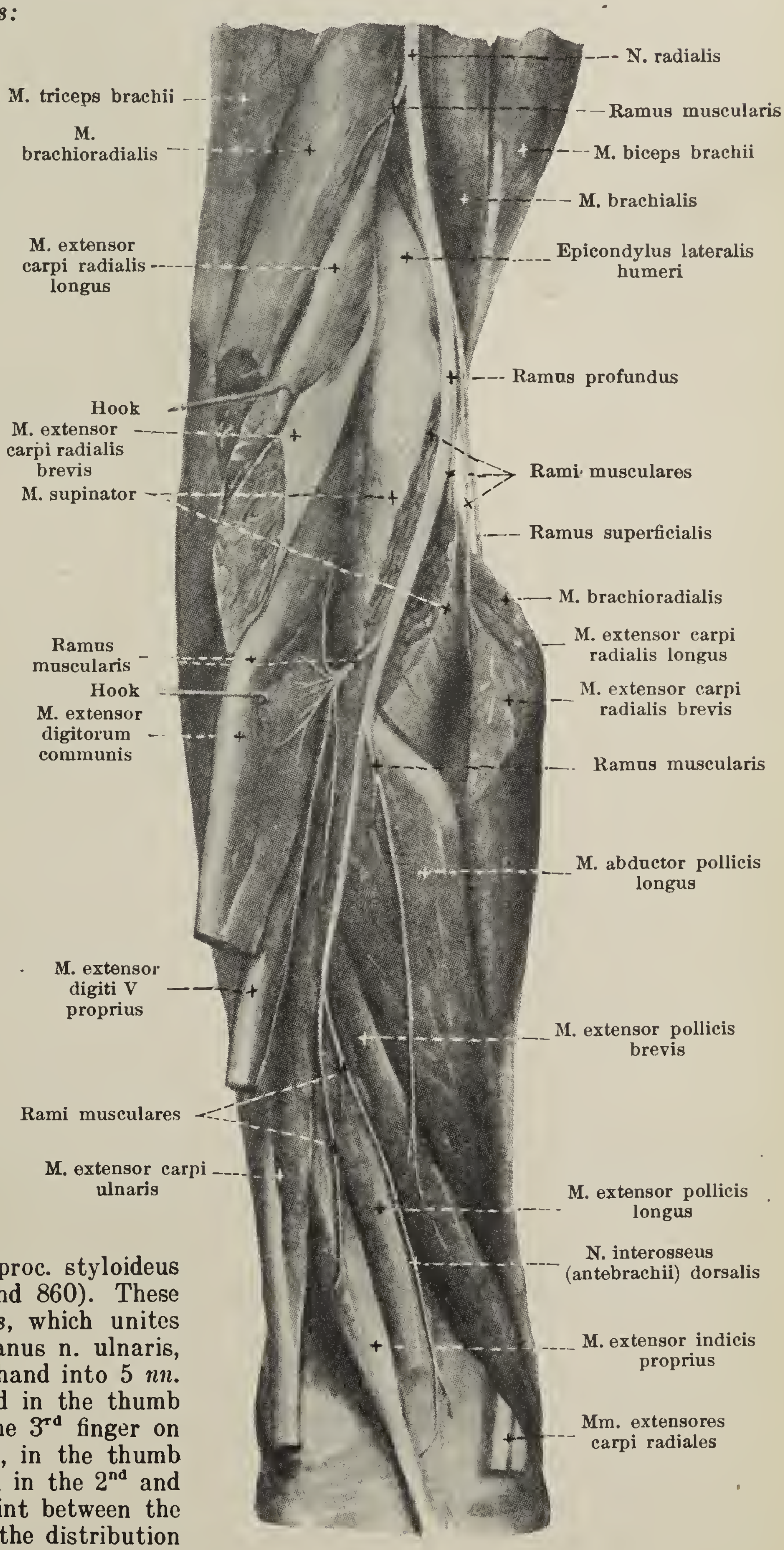
Terminal branches of the n. radialis:

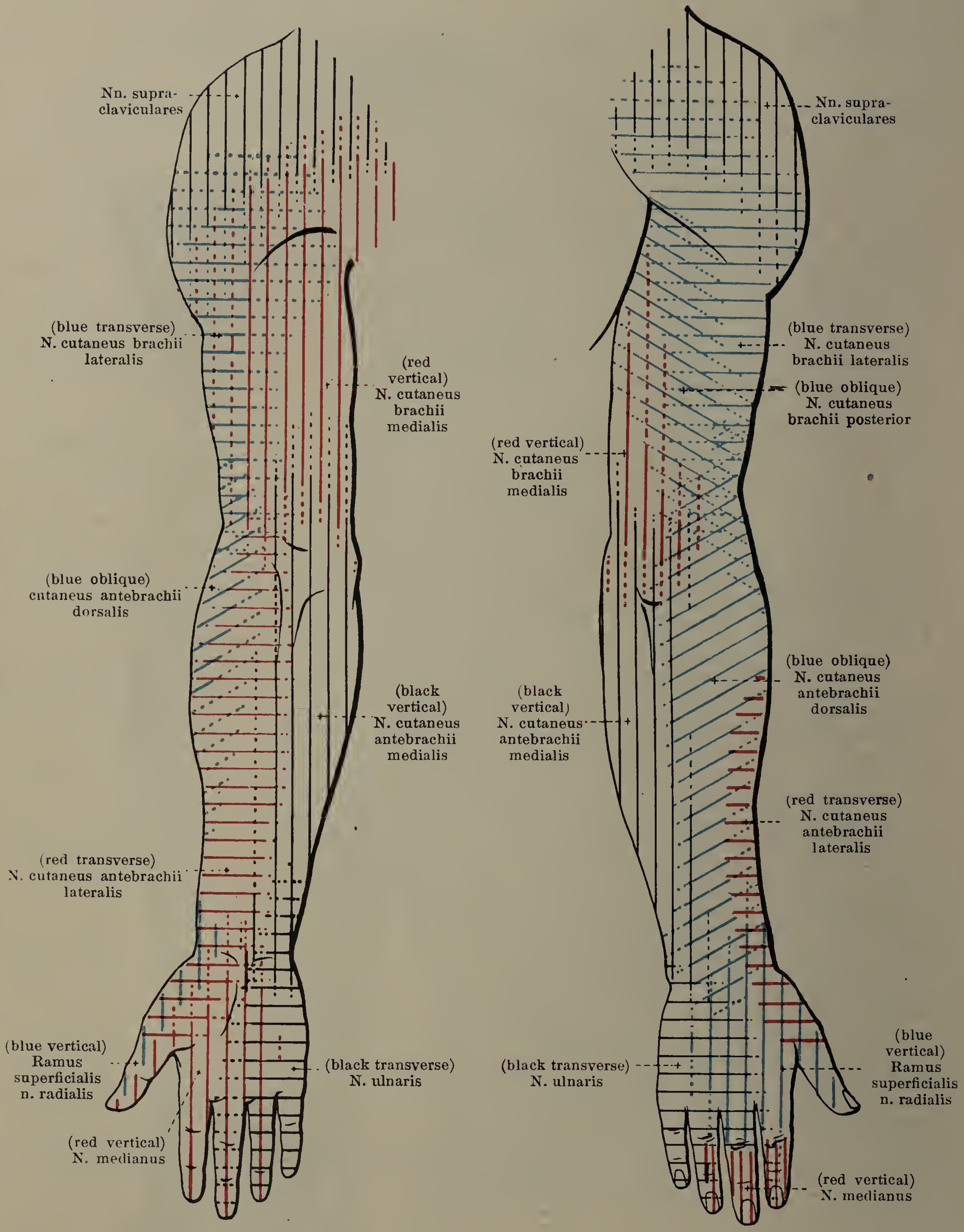
e) *Ramus profundus* (see also Figs. 855 and 857), the larger of the two, penetrates the volar surface of the m. supinator, and passes within this muscle in a long spiral winding around the collum radii to the dorsal surface of the radius, where it runs distalward upon the mm. abductor pollicis longus and extensores pollicis and ends as the *n. interosseus [antebrachii] dorsalis.* It gives off:

α) *Rami musculares,* before entrance into the m. supinator, to the mm. extensor carpi radialis brevis (C_6, C_7 [C_8]) and supinator ([C_5] C_6, C_7, C_8), on the back of the forearm to the mm. extensores digitorum communis ([C_6] C_7, C_8), digiti V proprius (C_7, C_8) and carpi ulnaris ([C_6] C_7, C_8), abductor pollicis longus, extensores pollicis and extensor indicis proprius ([C_6] C_7, C_8).

β) *N. interosseus [antebrachii] dorsalis* passes between the mm. extensores pollicis to the membrana interossea and upon it to the bones and ligaments of the forearm and of the hand.

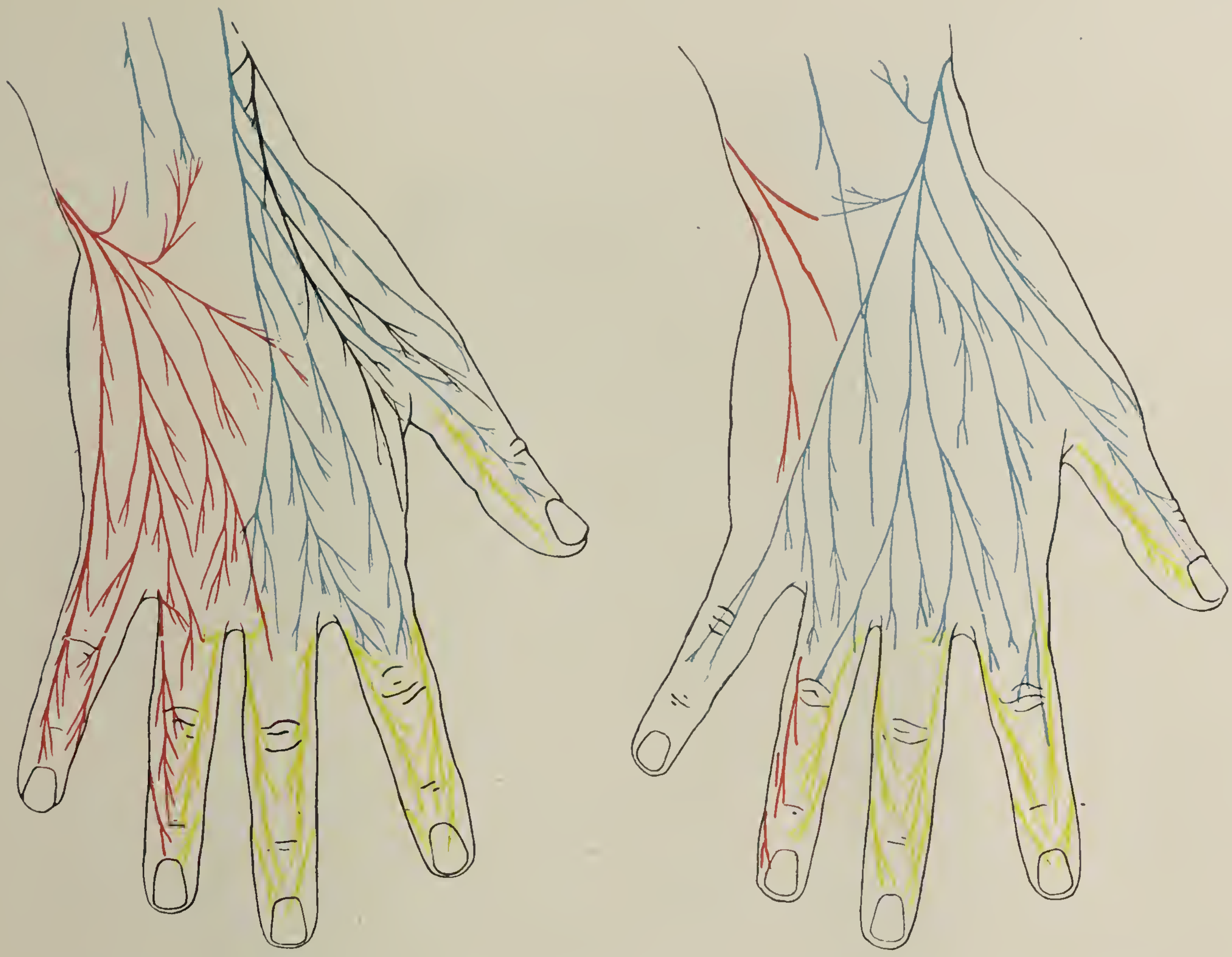
f) *Ramus superficialis* (see also Figs. 855—858, 860, 861 and 864—867) runs (see Figs. 856 and 857) distalward in front of the m. supinator behind the ulnar margin of the m. brachioradialis, at first near the a. recurrens radialis, then radialward from the a. radialis; it passes in a long curve between the m. brachioradialis and m. extensor carpi radialis longus gradually to the radial margin of the forearm, and there perforates the fascia antebrachii in the lower third of the forearm. Here it anastomoses with the n. cutaneus antebrachii lateralis and divides into two branches, which pass upon the lig. carpi dorsale over the lateral surface of the proc. styloideus radii to the hand (see Figs. 857, 858 and 860). These give off a *ramus anastomoticus ulnaris,* which unites with branches of the ramus dorsalis manus n. ulnaris, and then divide upon the fascia of the hand into 5 *nn. digitales dorsales.* These run distalward in the thumb and index finger on both margins, in the 3rd finger on the radial margin of the dorsal surface, in the thumb regularly as far as the base of the nail, in the 2nd and 3rd finger usually only as far as the joint between the 1st and the 2nd phalanx. Variations in the distribution of the n. radialis in the hand are common (see Fig. 867).


N. radialis
M. triceps brachii
Ramus muscularis
M. brachioradialis
M. biceps brachii
M. brachialis
M. extensor carpi radialis longus
Epicondylus lateralis humeri
Ramus profundus
Hook
M. extensor carpi radialis brevis
Rami musculares
M. supinator
Ramus superficialis
M. brachioradialis
M. extensor carpi radialis longus
Ramus muscularis
Hook
M. extensor carpi radialis brevis
M. extensor digitorum communis
Ramus muscularis
M. abductor pollicis longus
M. extensor digiti V proprius
M. extensor pollicis brevis
Rami musculares
M. extensor carpi ulnaris
M. extensor pollicis longus
N. interosseus (antebrachii) dorsalis
M. extensor indicis proprius
Mm. extensores carpi radiales


Nn. supraclaviculares
(blue transverse) N. cutaneus brachii lateralis
(red vertical) N. cutaneus brachii medialis
(blue oblique) cutaneus antebrachii dorsalis
(black vertical) N. cutaneus antebrachii medialis
(red transverse) N. cutaneus antebrachii lateralis
(blue vertical) Ramus superficialis n. radialis
(black transverse) N. ulnaris
(red vertical) N. medianus
Nn. supraclaviculares
(blue transverse) N. cutaneus brachii lateralis
(blue oblique) N. cutaneus brachii posterior
(red vertical) N. cutaneus brachii medialis
(blue oblique) N. cutaneus antebrachii dorsalis
(black vertical) N. cutaneus antebrachii medialis
(red transverse) N. cutaneus antebrachii lateralis
(blue vertical) Ramus superficialis n. radialis
(black transverse) N. ulnaris
(red vertical) N. medianus

864 and 865. Areas of distribution of the cutaneous nerves of the right arm,
viewed from in front. viewed from behind.

(The areas constantly supplied by the nerves concerned are indicated by solid lines, those inconstantly supplied by dotted lines.)



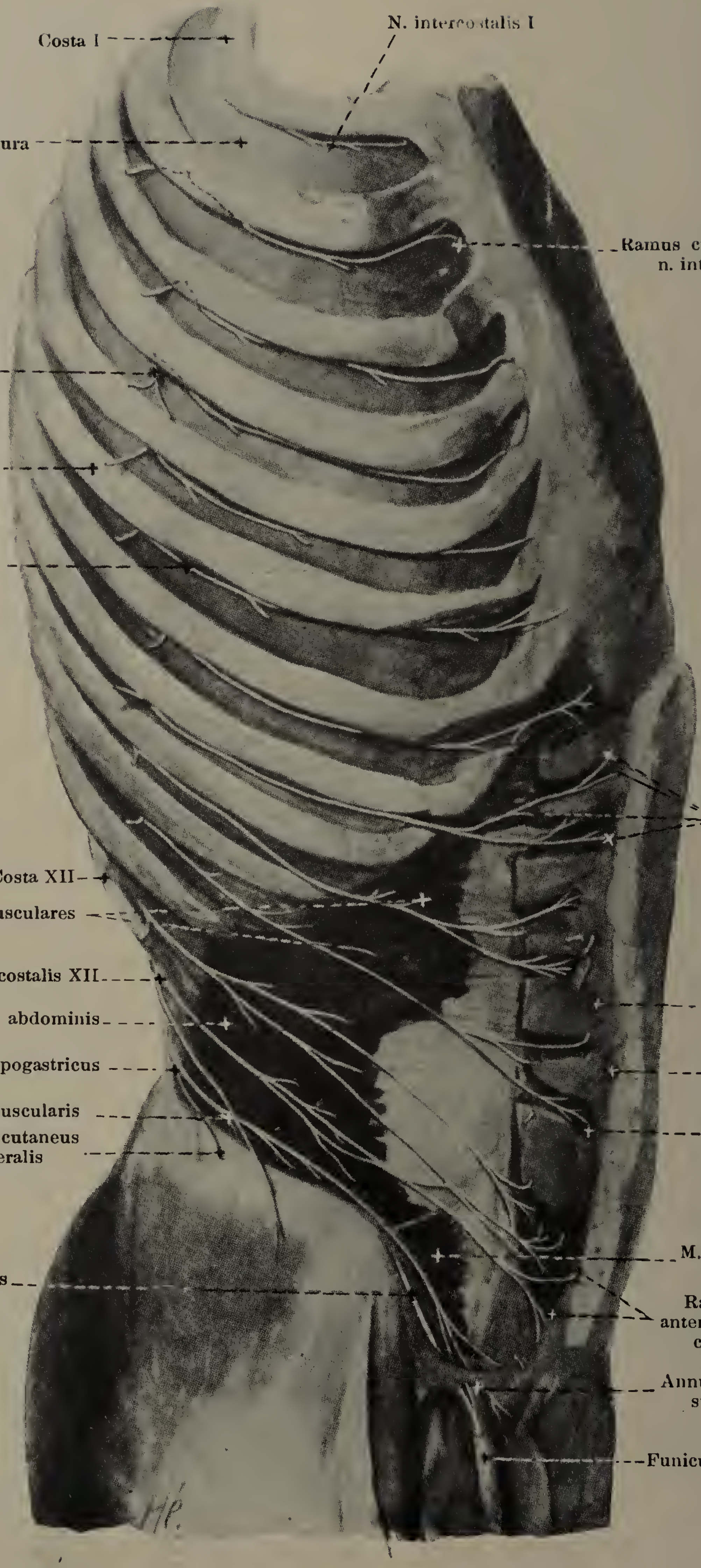
866 and 867. **Branching of the cutaneous nerves on the back of the right hand** (after E. Hédon) (see also Fig. 860).

Ordinary arrangement. Arrangement when the ramus superficialis n. radialis is markedly developed.

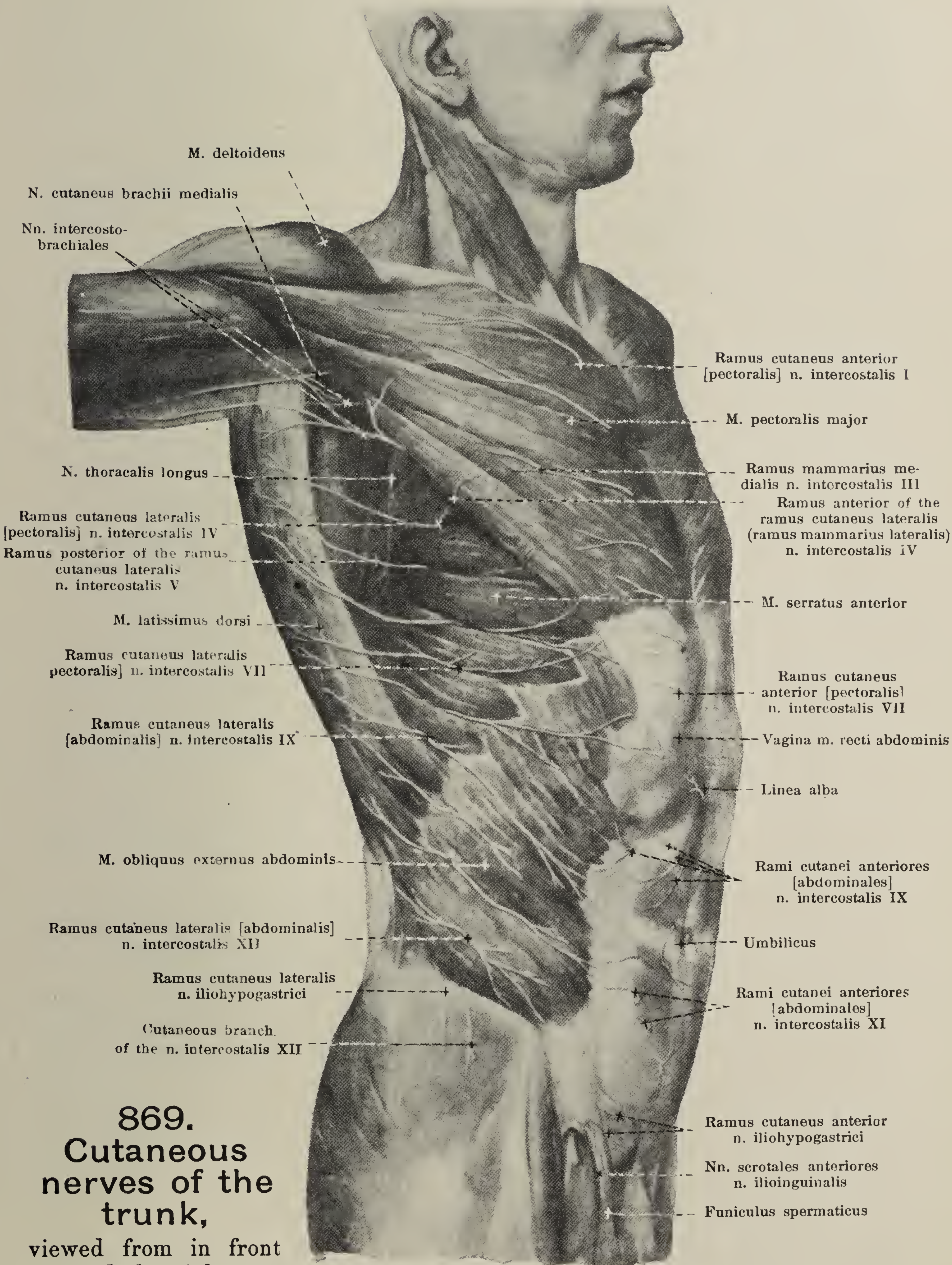
(Black: n. cutaneus antebrachii lateralis; red: n. ulnaris; blue: n. radialis; yellow: n. medianus.)

The ***rami anteriores of the nn. thoracales*** (see Figs. 743, 839, 868, 869, 871 and 890) go forward in a curve in the intercostal spaces (the 12th at the lower margin of the 12th rib), and hence are called the ***nn. intercostales.*** Each of them (see Fig. 743 and 890) is connected at its beginning by one or several *rami communicantes* with the ganglia or truncus of the sympathicus. Most of the intercostal nerves form an anastomosis only exceptionally with adjacent ones where they begin; such connections are constantly present only between the 1st thoracic and the 8th cervical nerve, since the former sends its main mass to the plexus brachialis (see p. 743) and goes on as the n. intercostalis I only by a delicate thread, and between the 12th thoracic and 1st lumbar nerve, whereby a part of the former goes over into the tract of the latter; usually also the 2nd thoracic nerve connects with the first and with the plexus brachialis (see p. 743).

Each runs just beneath the a. intercostalis (see also Figs. 363, 680 and 681) lateralward in front of the lig. costotransversarium anterius and internal from the mm. intercostales externi, covered only by the fascia endothoracica and pleura, in the middle of the intercostal space, then at the angulus costae approaches the upper rib: it passes along it behind between the mm. intercostales externi and interni, in front between the two layers of the latter as far as the anterior extremity of the bones of the ribs and then comes to the inner side of the mm. intercostales interni (see p. 285), there to pass again to the middle of the intercostal space. It ends in the 1st—6th intercostal space near the sternum in a ramus cutaneus anterior pectoralis. The 7th, 8th and 9th pass behind the anterior ends of the costal cartilages, the 10th, 11th and 12th under the anterior end of the corresponding rib, between the mm. obliquus internus abdominis and transversus abdominis and go medianward between these in the direction of the bony ribs as far as the m. rectus abdominis; the 7th assumes between the abdominal muscles a course ascending somewhat cranialward, the 8th an approximately horizontal, the 9th—12th a course descending more and more caudalward.


Costa I
N. intercostalis I
Pleura
Ramus cutaneus anterior n. intercostalis II
Ramus cutaneus lateralis n. intercostalis IV
Costa VI
N. intercostalis VI
Rami cutanei anteriores n. intercostalis VIII
Costa XII
Rami musculares
N. intercostalis XII
M. transversus abdominis
N. iliohypogastricus
N. iliohypogastricus { ramus muscularis
ramus cutaneus lateralis
Vagina m. recti abdominis
Umbilicus
M. rectus abdominis (exposed)
M. obliquus internus abdominis
N. ilioinguinalis
Rami cutanei anteriores n. intercostalis XII
Annulus inguinalis subcutaneus
Funiculus spermaticus
HP.

868. Course of the right intercostal nerves, viewed from the right and in front. (The mm. intercostales and obliqui abdominis have been removed; pieces have been cut out of the m. rectus abdominis.)


M. deltoideus
N. cutaneus brachii medialis
Nn. intercosto-brachiales
N. thoracalis longus
Ramus cutaneus lateralis [pectoralis] n. intercostalis IV
Ramus posterior of the ramus cutaneus lateralis n. intercostalis V
M. latissimus dorsi
Ramus cutaneus lateralis pectoralis] n. intercostalis VII
Ramus cutaneus lateralis [abdominalis] n. intercostalis IX
M. obliquus externus abdominis
Ramus cutaneus lateralis [abdominalis] n. intercostalis XII
Ramus cutaneus lateralis n. iliohypogastrici
Cutaneous branch of the n. intercostalis XII
Ramus cutaneus anterior [pectoralis] n. intercostalis I
M. pectoralis major
Ramus mammarius medialis n. intercostalis III
Ramus anterior of the ramus cutaneus lateralis (ramus mammarius lateralis) n. intercostalis IV
M. serratus anterior
Ramus cutaneus anterior [pectoralis] n. intercostalis VII
Vagina m. recti abdominis
Linea alba
Rami cutanei anteriores [abdominales] n. intercostalis IX
Umbilicus
Rami cutanei anteriores [abdominales] n. intercostalis XI
Ramus cutaneus anterior n. iliohypogastrici
Nn. scrotales anteriores n. ilioinguinalis
Funiculus spermaticus

869. Cutaneous nerves of the trunk, viewed from in front and the right.

(Figs. 868 and 869 have been drawn from the same cadaver.)

N. intercostales (continued): In the whole length of their course they give off delicate *rami musculares* to the neighboring muscles (see Figs. 868 and 890), including the mm. intercostales externi, interni (and subcostales) and levatores costarum from Th$_1$—Th$_{11}$, mm. serratus posterior superior from Th$_1$—Th$_4$, serratus posterior inferior from Th$_9$—Th$_{11}$, transversus thoracis from (Th$_2$) Th$_3$—Th$_6$, mm. obliquus externus and transversus abdominis from Th$_5$ to Th$_{12}$, m. rectus abdominis from Th$_6$—Th$_{12}$, m. obliquus internus abdominis (Th$_{10}$—Th$_{12}$) and m. pyramidalis from Th$_{12}$; in addition, sensory fibres go to the peritonaeum of the anterior abdominal wall and to the marginal zone of the diaphragm.

Each n. intercostalis gives off two cutaneous branches, *rami cutanei lateralis et anterior.*

a) *Ramus cutaneus lateralis [pectoralis et abdominalis]* (see Figs. 868 and 869) goes off about midway between the spine and the sternum, is usually larger than the continuation of the trunk, and is absent only on the 1st intercostal nerve. It appears between the digitations of the m. serratus anterior, lower down between those of the mm. latissimus dorsi and obliquus externus abdominis, about midway between the mamillary and axillary lines, and divides into two branches. The *ramus posterior* passes around the lateral margin of the m. latissimus dorsi, approximately horizontal, to the skin, toward the branches of the rami posteriores nn. thoracalium (see also Fig. 842 and p. 740); the branch of the 2nd and sometimes of the 3rd intercostal nerve unites, as the *n. intercostobrachialis* (see also Fig. 849), with the n. cutaneus brachii medialis, and goes wholly or in part to the skin of the medial surface of the upper arm. The *ramus anterior* of the 2nd—6th intercostal nerve bends around the lateral margin of the m. pectoralis major medianward to the skin over this muscle; in the female branches from the 4th—6th nerve, *rami mammarii laterales*, enter the mammary gland; the anterior ramus of the 7th—11th intercostal nerve passes upon the external surface of the m. obliquus externus abdominis obliquely downward and medianward to almost in front of the sheath of the rectus, that of the 12th usually runs with a large branch over the crista iliaca downward to the skin upon the mm. glutaeus medius and tensor fasciae latae and there alternates with the ramus cutaneus lateralis n. iliohypogastrici (see also Figs. 874, 885, 886 and p. 768).

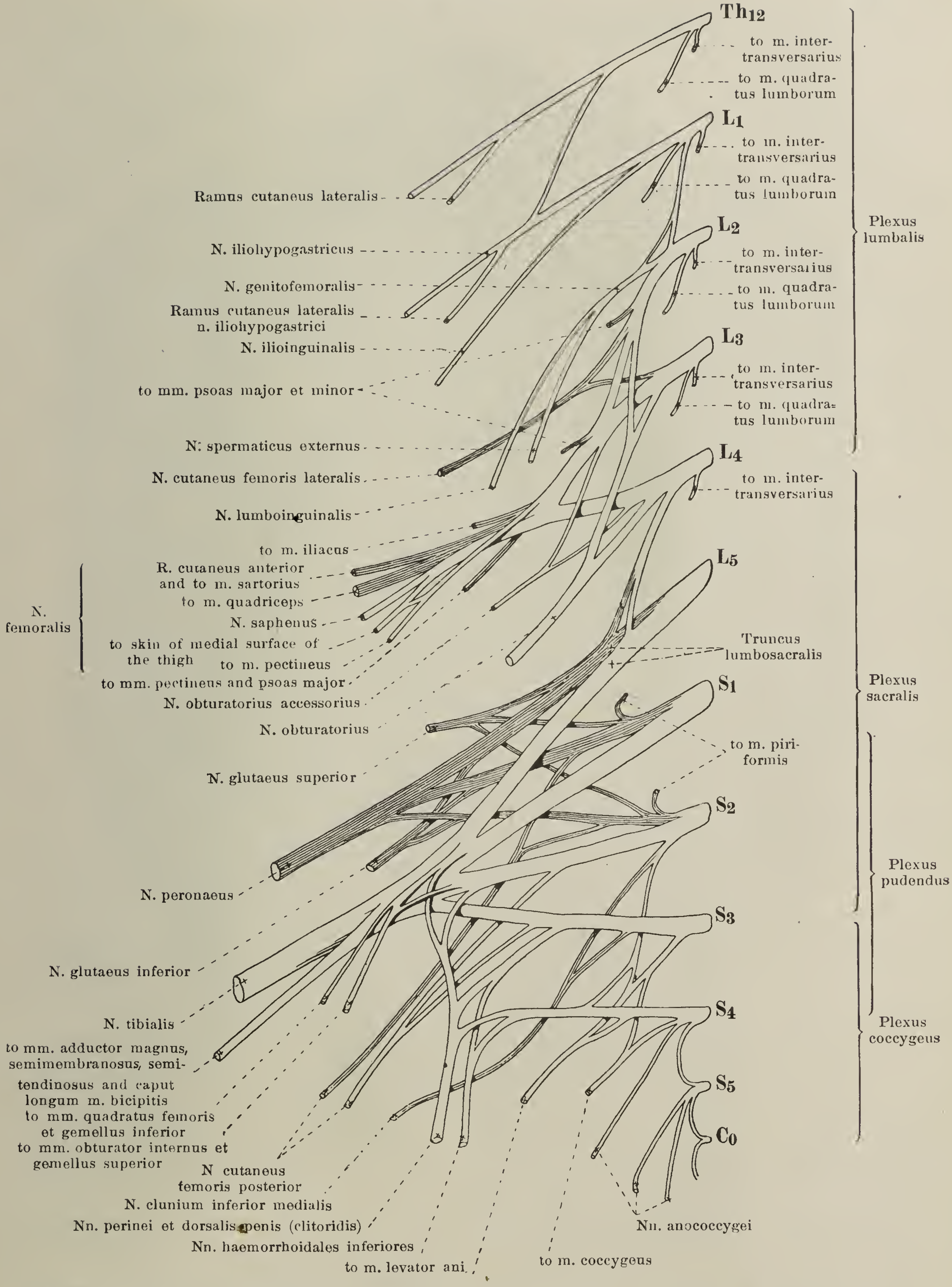
b) *Ramus cutaneus anterior [pectoralis et abdominalis]* (see Figs. 868 and 869) passes from the upper 6 intercostal nerves close to the lateral margin of the sternum through the m. pectoralis major to the skin of the anterior surface of the chest; branches from the 2nd—4th pass as *rami mammarii mediales* to the mammary gland in the female. Those from the lower 6 intercostal nerves perforate the m. rectus abdominis and the anterior layer of the rectal sheath, often subdivided into several twigs, and go to the skin in front of the same, that of the 10th usually at the level of the umbilicus.

The ***rami anteriores of the nn. lumbales*** pass through the foramina intervertebralia, those of the ***nn. sacrales*** through the foramina sacralia anteriora (see Figs. 871 and 876); that of the ***n. coccygeus*** (see Fig. 742) runs through the hiatus sacralis between the ligg. sacrococcygea posteriora, surrounds the root of the cornu coccygeum from below and perforates the lig. sacrospinosum and the m. coccygeus. In general they increase in size from L$_1$ to S$_1$, then quickly decrease; they are all connected with the trunk and ganglia of the sympathicus by one or several rami communicantes (see Figs. 871 and 876). They all anastomose with one another and thus form the large *plexus lumbosacralis* (see Figs. 870, 871 and 876), which is subdivisible into the *plexus lumbalis, plexus sacralis* (see p. 773), *plexus pudendus* (see p. 786) and *plexus coccygeus* (see p. 787).

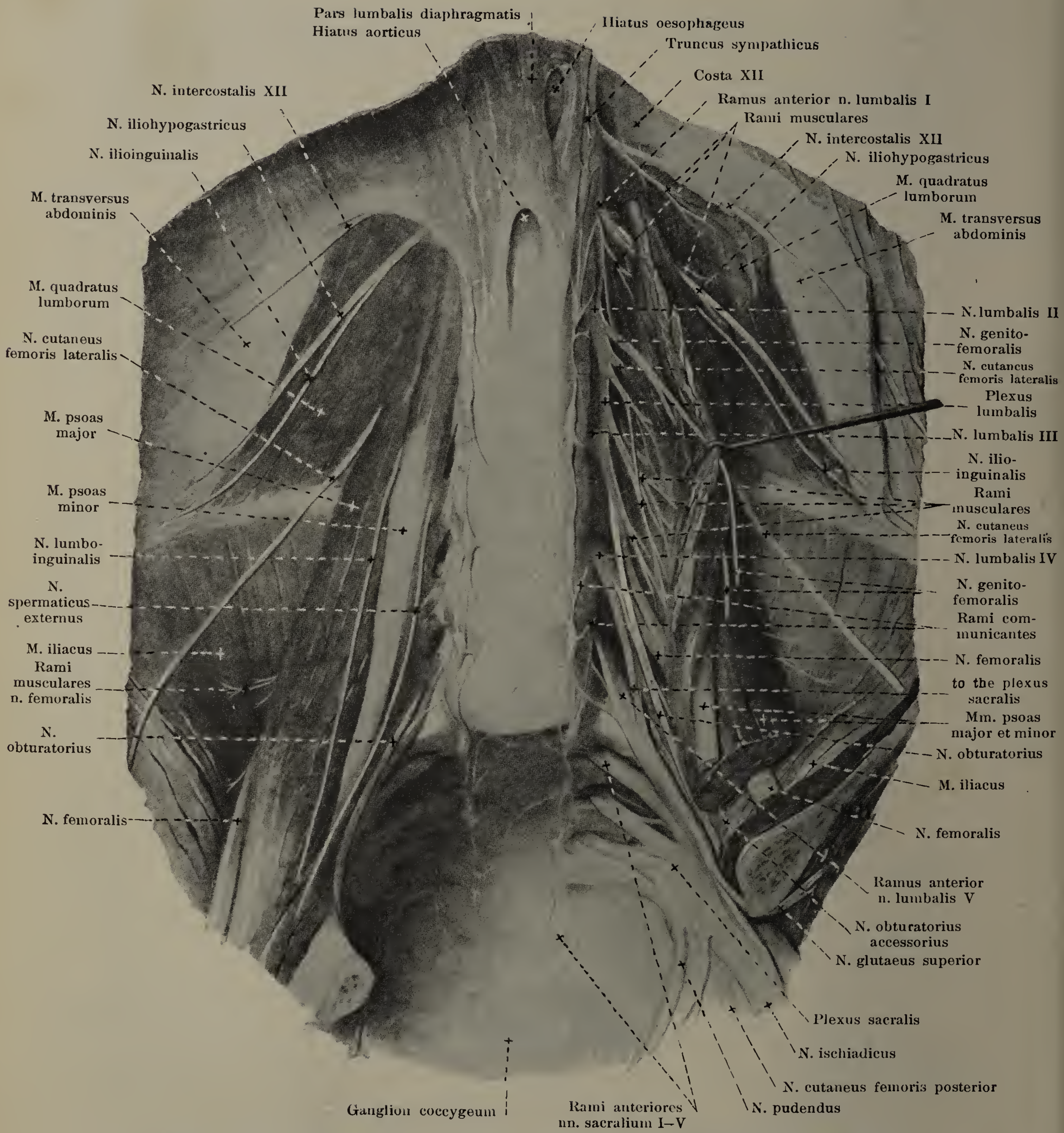
The ***plexus lumbalis*** (see Figs. 870 and 871) is formed by the whole of the 1st, 2nd and 3rd and a part of the 4th lumbar nerve and receives also fibres from the n. intercostalis XII through one of its branches. It lies in front of the procc. transversi of the lumbar vertebrae within the m. psoas major, between its origins from the vertebral bodies and from the procc. transversi. It gives off:

1. *Rami musculares* (see Figs. 870 and 871), short, directly from the roots of the plexus, to the mm. intertransversarii laterales from Th$_{12}$, L$_1$—L$_5$, and to the m. quadratus lumborum from (Th$_{12}$) L$_1$ (L$_2$); farther to the m. psoas major from L$_2$, L$_3$ and L$_4$ and to the m. psoas minor from L$_1$ and L$_2$ (perforates the m. psoas major).

2. *N. iliohypogastricus* (see Figs. 868—871, 874, 879, 885 and 886), from Th$_{12}$ and L$_1$, often in a common stem with the n. ilioinguinalis, is larger than the latter and together with it corresponds in its behavior almost exactly to an intercostal nerve. It runs (see Fig. 871), at first parallel to the 12th intercostal nerve, in front of the m. quadratus lumborum and behind the lower part of the kidney lateralward and downward to the tendon of the m. transversus abdominis which it perforates above the crista iliaca. Thence it passes (see Figs. 868 and 874), at first between the mm. transversus and obliquus internus abdominis, close above the crista iliaca, then between the mm. obliqui abdominis, above the ligamentum inguinale as far as into the sheath of the rectus; from this part of its course it gives off an anastomosis to the n. ilioinguinalis. During its entire course between the broad muscles of the abdomen it gives off *rami musculares* to them, as well as sensory branches to the peritonaeum. In addition it gives off:


Th12
to m. intertransversarius
to m. quadratus lumborum
L1
to m. intertransversarius
to m. quadratus lumborum
Plexus lumbalis
Ramus cutaneus lateralis
N. iliohypogastricus
L2
to m. intertransversarius
N. genitofemoralis
to m. quadratus lumborum
Ramus cutaneus lateralis n. iliohypogastrici
N. ilioinguinalis
L3
to m. intertransversarius
to mm. psoas major et minor
to m. quadratus lumborum
N. spermaticus externus
N. cutaneus femoris lateralis
L4
to m. intertransversarius
N. lumboinguinalis
to m. iliacus
N. femoralis
R. cutaneus anterior and to m. sartorius
L5
to m. quadriceps
N. saphenus
to skin of medial surface of the thigh
to m. pectineus
Truncus lumbosacralis
to mm. pectineus and psoas major
Plexus sacralis
N. obturatorius accessorius
S1
N. obturatorius
to m. piriformis
N. glutaeus superior
S2
Plexus pudendus
N. peronaeus
S3
N. glutaeus inferior
N. tibialis
S4
Plexus coccygeus
to mm. adductor magnus, semimembranosus, semitendinosus and caput longum m. bicipitis
S5
to mm. quadratus femoris et gemellus inferior
Co
to mm. obturator internus et gemellus superior
N cutaneus femoris posterior
N. clunium inferior medialis
Nn. perinei et dorsalis penis (clitoridis)
Nn. anococcygei
Nn. haemorrhoidales inferiores
to m. levator ani
to m. coccygeus

870. Right plexus lumbosacralis, schematic, viewed from in front (after P. Eisler). (The rami communicantes are not shown.) (The darkly shaded trunks are derivatives of the dorsal half of the plexus



871. Branches of the plexus lumbosacralis, viewed from in front.

The anterior part of the pelvis and the viscera have been removed; on the left in addition the mm. psoas and quadratus lumborum have been partly loosened and reflected.)

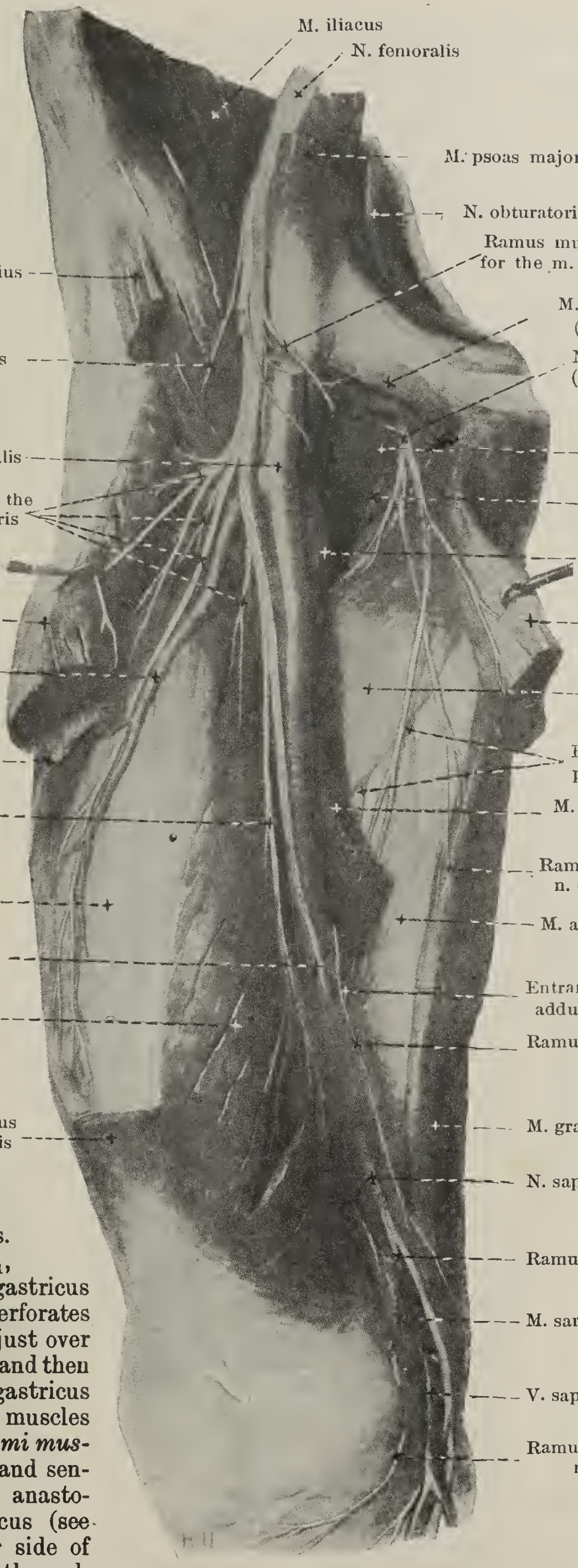
2. *N. iliohypogastricus* (continued) (see also Figs. 868, 869, 879, 885 and 886):

α) ***Ramus cutaneus lateralis*** goes downward over the middle of the crista iliaca through the mm. obliqui abdominis to the skin over the mm. glutaeus medius and tensor fasciae latae. Its size and area of distribution vary inversely as those of the corresponding branch of the ramus cutaneus lateralis n. intercostalis XII (see p. 766).

872. Muscle nerves of the right thigh,

viewed from in front.

(The thigh is rotated outward. The mm. sartorius, rectus femoris, vastus lateralis, pectineus and adductor longus have been partly removed.)


M. iliacus
N. femoralis
M. psoas major
N. obturatorius
Ramus muscularis for the m. pectineus
M. sartorius
M. pectineus (cut off)
Ramus muscularis
N. obturatorius (ramus anterior)
M. obturator externus
A. femoralis
N. obturatorius (ramus posterior)
Rami musculares for the m. quadriceps femoris
M. pectineus (cut off)
Hook
Hook
M. rectus femoris
M. adductor longus
A. circumflexa femoris lateralis (ramus descendens)
M. adductor brevis
M. vastus lateralis
Branches of the ramus posterior n. obturatorii
Ramus muscularis for the m. vastus medialis
M. adductor longus (cut off)
Ramus cutaneus n. obturatorii
M. vastus intermedius
M. adductor magnus
N. saphenus
Entrance to the canalis adductorius [Hunteri]
M. vastus medialis
Ramus cutaneus anterior n. femoralis
M. rectus femoris
M. gracilis
N. saphenus
Ramus infrapatellaris
M. sartorius
V. saphena magna
Ramus infrapatellaris n. sapheni

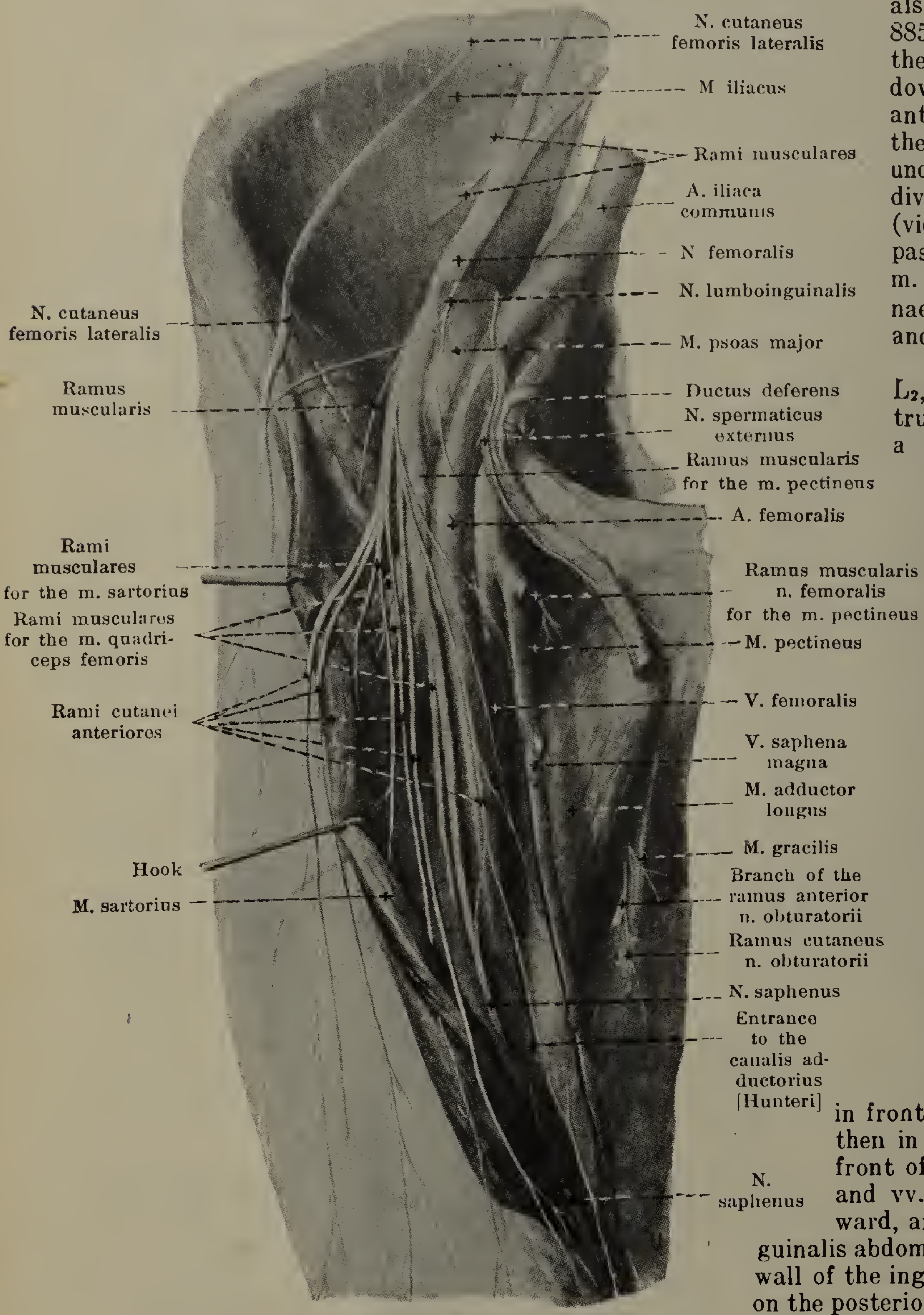
2. *N. iliohypogastricus* (continued) (see Figs. 868, 869 and 874):

b) ***Ramus cutaneus anterior*** goes from the anterior end of the nerve somewhat above the annulus inguinalis subcutaneus through the anterior leaf of the sheath of the rectus and then downward to the skin of the region pubica.

3. *N. ilioinguinalis* (see Figs. 868—871, 874 and 885), from L_1, runs close under the n. iliohypogastricus (q. v.) downward and lateralward, perforates the tendon of the m. transversus just over the posterior part of the crista iliaca and then passes similarly to the n. iliohypogastricus but below it, between the abdominal muscles forward. In its course it gives off ***rami musculares*** to the abdominal muscles and sensory branches to the peritonaeum, anastomoses with the n. iliohypogastricus (see p. 766) and at the upper anterior side of the funiculus spermaticus, passes through the annulus inguinalis subcutaneus. There it gives off descending branches to the uppermost, medial part of the thigh, which anastomose with branches of the n. spermaticus and may take the place of these, and ***rami scrotales (labiales) anteriores*** transversely to the lower part of the mons pubis, as well as to the anterior upper part of the scrotum (labium majus in the female).

873. Nerves of the right thigh, viewed from in front.

(The fascia lata has been partly removed; the m. sartorius has been lifted and drawn aside.)

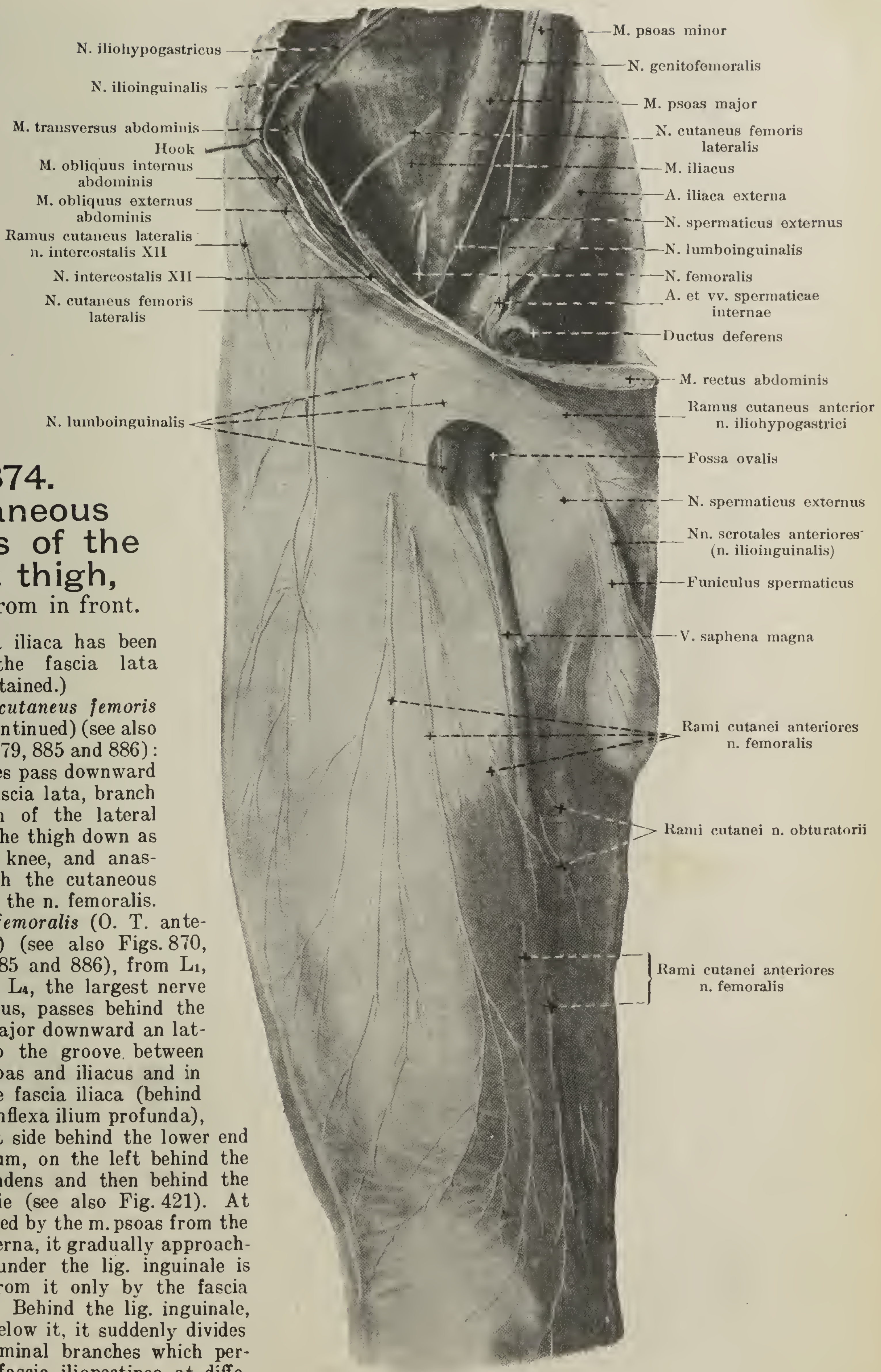

N. cutaneus femoris lateralis
M iliacus
Rami musculares
A. iliaca communis
N femoralis
N. lumboinguinalis
M. psoas major
Ductus deferens
N. spermaticus externus
Ramus muscularis for the m. pectineus
A. femoralis
Ramus muscularis n. femoralis for the m. pectineus
M. pectineus
V. femoralis
V. saphena magna
M. adductor longus
M. gracilis
Branch of the ramus anterior n. obturatorii
Ramus cutaneus n. obturatorii
N. saphenus
Entrance to the canalis adductorius [Hunteri]
N. saphenus
N. cutaneus femoris lateralis
Ramus muscularis
Rami musculares for the m. sartorius
Rami musculares for the m. quadriceps femoris
Rami cutanei anteriores
Hook
M. sartorius

4. *N. genitofemoralis* (see also Figs. 870, 871, 874 and 885), from L_1 and L_2, perforates the m. psoas major obliquely downward and appears on its anterior surface at the level of the third lumbar vertebra, either undivided (see Fig. 874) or subdivided into its two branches (vide infra) (see Fig. 871). It passes downward in front of the m. psoas, behind the peritonaeum, and behind the ureter, and divides into two branches:

a) *N. lumboinguinalis*, from L_2, runs in the direction of the trunk downward, behind the a and vv. spermaticae internae, first behind, then in front of the fascia iliaca, lateral from the a. iliaca externa, and in its course often gives off a branch to the n. cutaneus femoris lateralis and not rarely one to the n. ilioinguinalis through the m. transversus abdominis. It then passes lateral from, and in front of, the a. femoralis through the lacuna vasorum, and partly in the fossa ovalis, partly lateral from it through the fascia to the skin in the neighborhood of the fossa ovalis, sometimes as far as the middle of the thigh. Its branches often anastomose with cutaneous branches of the n. femoralis.

b) *N. spermaticus externus*, from L_1 and L_2, runs in front of the m. psoas, first behind, then in front of the fascia iliaca, in front of the a. iliaca externa and the a. and vv. spermaticae internae, downward, arrives through the annulus inguinalis abdominalis or through the posterior wall of the inguinal canal into this and goes on the posterior inferior surface of the funiculus spermaticus through the annulus inguinalis subcutaneus to the m. cremaster (L_2 or L_1, L_2) to the tunica dartos, to the skin of the scrotum (labium majus in the female) an to the uppermost medial part of the tigh. It also gives fibres to the mm. obliquus internus and transversus abdominis, anastomoses with branches of the n. ilioinguinalis and may take its place.

5. *N. cutaneus femoris lateralis* (O. T. external cutaneous) (see also Figs. 870, 871, 874, 876, 879, 885 and 886), from L_2 and L_3, passes behind or through the m. psoas major, in front of the m. quadratus lumborum, crista ilica and the m. iliacus, behind the fascia iliaca, downward and lateralward, on the right side behind the caecum, on the left behind the colon descendens, often receiving a branch of the n. lumboinguinalis. It then goes behind the a. circumflexa ilium profunda, medial from the spina iliaca anterior superior, behind the lig. inguinale downward and, in front of the m. sartorius, perforates the fascia lata, usually with two or three separate branches. It may be included in the n. femoralis as far as the lig. inguinale.


N. iliohypogastricus
N. ilioinguinalis
M. transversus abdominis
Hook
M. obliquus internus abdominis
M. obliquus externus abdominis
Ramus cutaneus lateralis n. intercostalis XII
N. intercostalis XII
N. cutaneus femoris lateralis
N. lumboinguinalis
M. psoas minor
N. genitofemoralis
M. psoas major
N. cutaneus femoris lateralis
M. iliacus
A. iliaca externa
N. spermaticus externus
N. lumboinguinalis
N. femoralis
A. et vv. spermaticae internae
Ductus deferens
M. rectus abdominis
Ramus cutaneus anterior n. iliohypogastrici
Fossa ovalis
N. spermaticus externus
Nn. scrotales anteriores (n. ilioinguinalis)
Funiculus spermaticus
V. saphena magna
Rami cutanei anteriores n. femoralis
Rami cutanei n. obturatorii
Rami cutanei anteriores n. femoralis

874.
Cutaneous nerves of the right thigh,
viewed from in front.

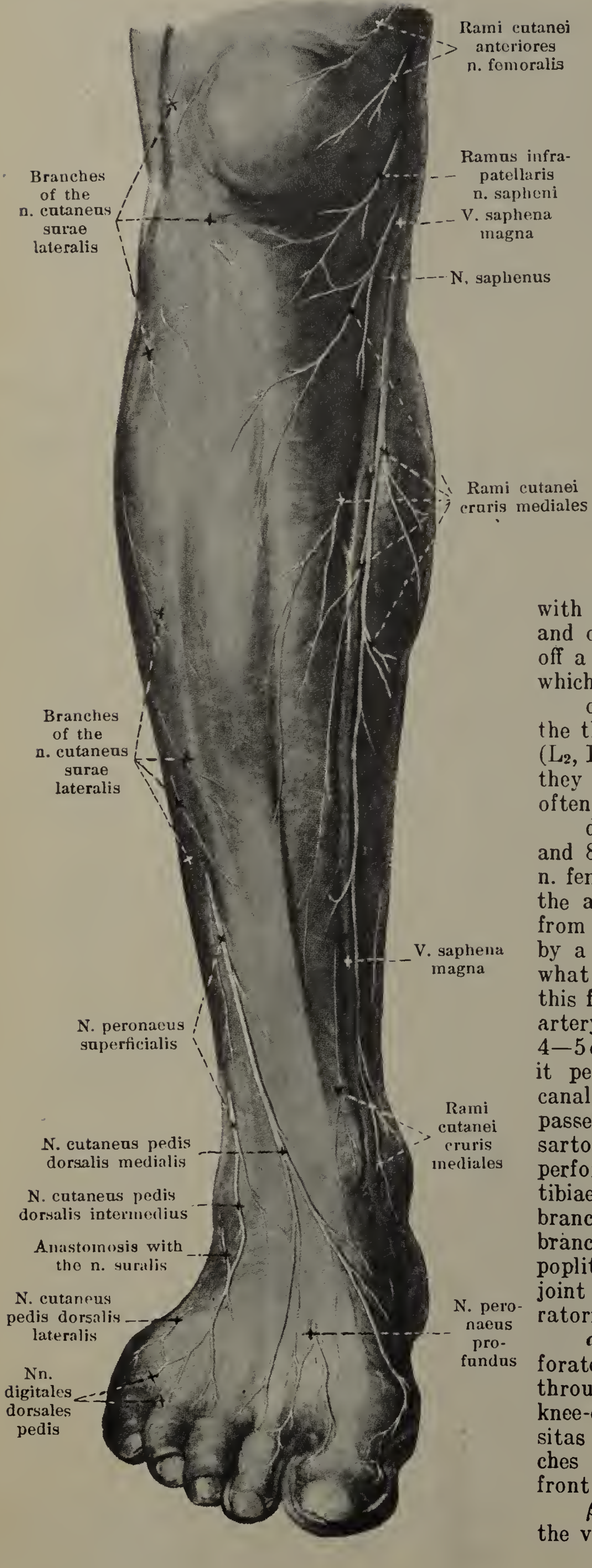
(The fascia iliaca has been removed, the fascia lata retained.)

5. *N. cutaneus femoris lateralis* (continued) (see also Figs 873, 879, 885 and 886): The branches pass downward upon the fascia lata, branch in the skin of the lateral surface of the thigh down as far as the knee, and anastomose with the cutaneous branches of the n. femoralis.

6. *N. femoralis* (O. T. anterior crural) (see also Figs. 870, 873, 875, 885 and 886), from L_1, L_2, L_3 and L_4, the largest nerve of the plexus, passes behind the m. psoas major downward an lateralward to the groove between the mm. psoas and iliacus and in it under the fascia iliaca (behind the a. circumflexa ilium profunda), on the right side behind the lower end of the caecum, on the left behind the colon descendens and then behind the lig. inguinale (see also Fig. 421). At first separated by the m. psoas from the a. iliaca externa, it gradually approaches it and under the lig. inguinale is separated from it only by the fascia iliopectinea. Behind the lig. inguinale, or a little below it, it suddenly divides into its terminal branches which perforate the fascia iliopectinea at different levels.

875. Cutaneous nerves of the right leg,

viewed from in front.


Rami cutanei anteriores n. femoralis
Ramus infrapatellaris n. spheni
V. saphena magna
N. saphenus
Rami cutanei cruris mediales
V. saphena magna
Rami cutanei cruris mediales
N. peronaeus profundus
Branches of the n. cutaneus surae lateralis
Branches of the n. cutaneus surae lateralis
N. peronaeus superficialis
N. cutaneus pedis dorsalis medialis
N. cutaneus pedis dorsalis intermedius
Anastomosis with the n. suralis
N. cutaneus pedis dorsalis lateralis
Nn. digitales dorsales pedis

(The fascia cruris has been retained.)

6. *N. femoralis* (continued): Branches:

a) *Rami musculares* (see Figs. 870—873), short, in the fossa iliaca to the m. iliacus (L_2, L_3) and to the distal part of the m. iliopsoas (L_2, L_3, L_4).

b) *Rami cutanei anteriores* (see also Figs. 872—874, 885 and 886), in two groups. One group goes partly through the m. sartorius, at the same time innervating it (L_2, L_3), partly over its medial margin through the fascia to the skin on the anterior surface of the thigh almost as far as the knee-cap; they anastomose above with branches of the nn. lumboinguinalis and cutaneus femoris lateralis. The others run along the medial margin of the m. sartorius, perforate the fascia at different levels and run, one close to the v. saphena magna, to the skin of the anterior medial surface of the thigh; they anastomose with branches of the ramus cutaneus n. obturatorii and of the n. saphenus; one of these branches gives off a *ramus muscularis* (L_2, L_3) for the m. pectineus which runs behind the a. and v. femoralis.

c) *Rami musculares* (see Figs. 872 and 873) in the thigh to the heads of the m. quadriceps femoris (L_2, L_3, L_4) and to the m. articularis genus (L_3, L_4); they send fine threads to the hip- and knee-joint, and often also a thread to the m. tensor fasciae latae (L_4).

d) *N. saphenus* (see also Figs. 872—874, 885 and 886) runs in a way as the continuation of the n. femoralis, covered by the m. sartorius, in front of the a. circumflexa femoris lateralis, at first lateral from the a. femoralis downward, separated from it by a continuation of the fascia iliopectinea; somewhat above the middle of the thigh it passes through this fascia, lies on the anterior medial surface of the artery and with it goes into the canalis adductorius. 4—5 cm below the entrance to the canalis adductorius it perforates the lamina vastoadductoria of the canalis, usually along with the a. genus suprema, passes downward on the posterior margin of the m. sartorius, behind the epicondylus medialis femoris, perforates the fascia at the level of the tuberositas tibiae and divides immediately into its two terminal branches. In the thigh it gives off a fine cutaneous branch to the medial surface of the thigh and to the popliteal space and an articular branch to the knee-joint and anastomoses with a branch of the n. obturatorius. Terminal branches:

α) Ramus infrapatellaris, goes around or perforates the tendon of the m. sartorius and passes through the fascia in the form of a curve under the knee-cap lateralward as far as in front of the tuberositas tibiae; it anastomoses with the cutaneous branches of the n. femoralis and supplies the skin in front of the knee-cap and beneath it.

β) The continuation of the main nerve runs along the v. saphena magna, usually behind it, distalward as far as the medial margin of the foot and anastomoses there with branches of the n. peronaeus superficialis. It sends *rami cutanei cruris mediales* to the anterior and posterior surfaces of the leg, which anastomose behind with branches of the n. cutaneus surae medialis.

7. *N. obturatorius* (see Figs. 870—874, 876, 879, 885 and 886), from (L_1), L_2, L_3 and L_4, goes almost vertically downward at first in the m. psoas major between the n. femoralis and truncus lumbosacralis, then leaves the m. psoas major on its medial surface in front of the articulatio sacroiliaca and then passes forward lateralward and downward somewhat below the linea terminalis and above the a. obturatoria directly upon the fascia pelvis to the canalis obturatorius; in its course it runs at first lateral from the vena, then from the a. hypogastrica, then from the ureter and in the female crosses the lateral surface of the ovarium. In the canalis obturatorius it gives off a branch to the dorsal surface of the m. obturator externus (L_3, L_4). It then divides into the two terminal branches:

a) *Ramus anterior* (see Figs. 872—874, 885 and 886) passes distalward over the upper margin of the m. obturator externus, then behind the mm. pectineus and adductor longus, between the latter and the m. adductor brevis, and gives off motor branches to the mm. adductores longus (L_2, L_3) and brevis (L_2, L_3, L_4), m. graciles (L_2, L_3, L_4) and not rarely to the m. pectineus (L_2, L_3). It ends as the *ramus cutaneus*, which usually passes between the mm. adductor longus and gracilis in the middle of the thigh through the fascia lata to the skin and supplies the lower half of the medial surface of the thigh. It anastomoses with the n. saphenus.

b) *Ramus posterior* (see Fig. 872) not infrequently perforates the m. obturator externus and runs downward between the mm. adductores brevis, minimus and magnus; it sends motor branches to the three mm. adductores mentioned (L_2, L_3, L_4) and branches to the hip-joint.

8. *N. obturatorius accessorius* (see Figs. 870 and 871), often present, from (L_2) L_3 and L_4, passes distalward under the fascia iliaca at the medial margin of the m. psoas major, then over the pecten oss. pubis and between the mm. iliopsoas and pectineus into the depth. It gives off branches to the latter and to the hip-joint and finally enters the n. obturatorius. When markedly developed it may partly substitute for the n. obturatorius.

Plexus sacralis (see Figs. 870, 871 and 876) is formed of the anterior branches of the nn. lumbales IV (partly) and V, as well as of the nn. sacrales I—III, all of which converge downward and lateralward. The n. lumbalis IV sends from half to nine-tenths of its fibres to the plexus sacralis; these are separated from the n. lumbalis V by the ramus iliacus a. iliolumbalis, and with it form a common stem, *truncus lumbosacralis*, which passes obliquely downward over the basal surface of the pars lateralis oss. sacri into the small pelvis and is separated from the n. sacralis I by the a. glutaea superior. The last root of the plexus arises usually from the n. sacralis III, more rarely II or IV. The plexus sacralis yields exclusively nerves for the pelvic girdle and the lower extremity.

The nerves for the pelvic viscera, for the muscles and for the skin of the perineum come from the *plexus pudendus* (see also p. 786), which is in a way a portion introduced into the plexus sacralis (see Fig. 870), and arises from S_1, S_2, S_3 and S_4.

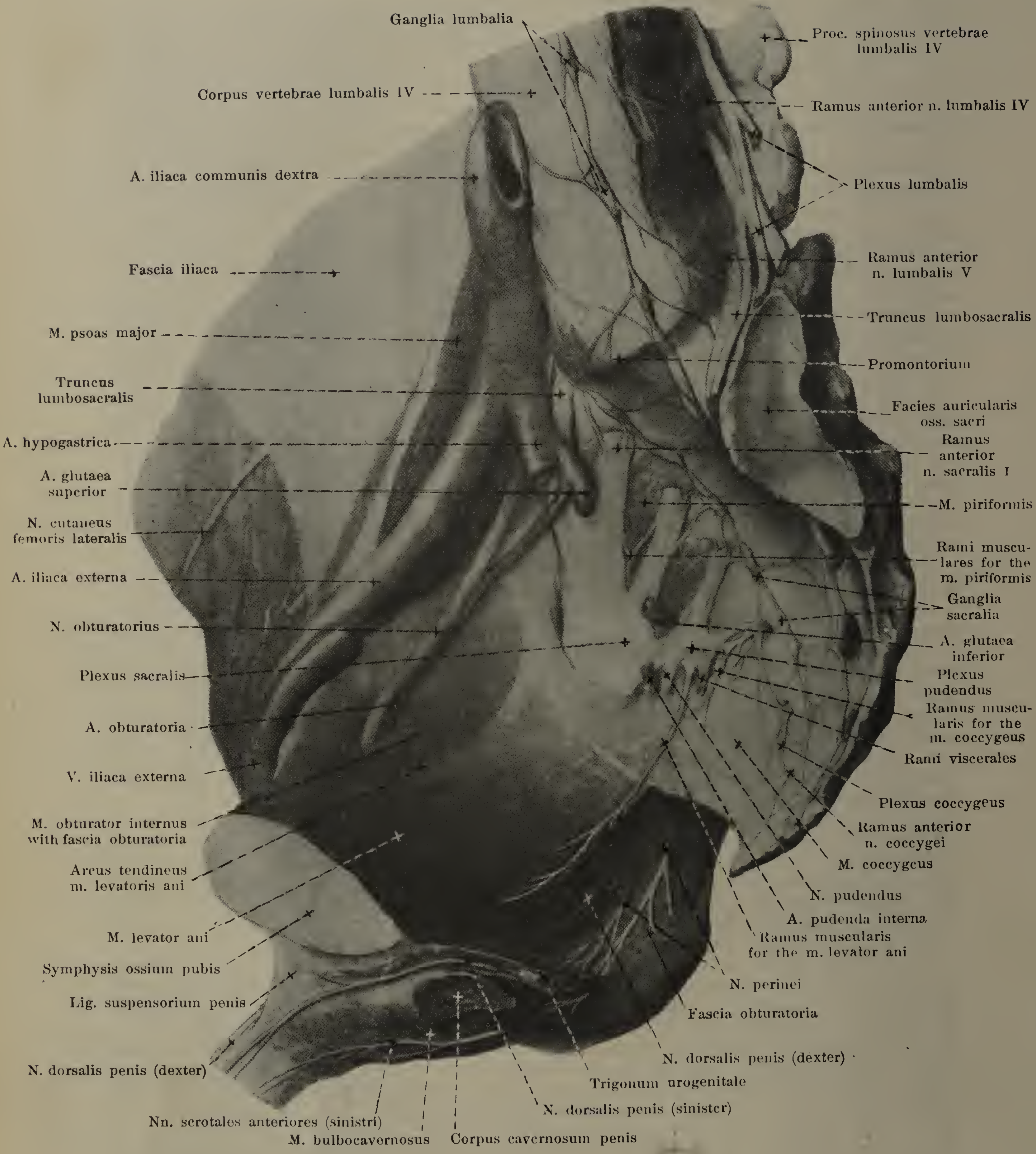
The plexus sacralis lies as a flat, triangular mass on the anterior surface of the m. piriformis as far as the upper margin of the m. coccygeus; its inferior apex is directed toward the lower portion of the foramen ischiadicum majus and goes over into the n. ischiadicus. The plexus is covered in front by the most posterior portion of the fascia pelvis, by the branching of the a. and v. hypogastrica and by peritonaeum and lies near the lateral surface of the rectum. It sends branches A. to the pelvic girdle and B. to the extremity.

A. Branches to the pelvic girdle:

1. *Rami musculares* a) for the m. piriformis (see Figs. 870 and 876) from S_1 and S_2, pass directly into the anterior surface of the muscle; b) for the mm. obturator internus, gemelli and quadratus femoris (see Figs. 870 and 877) from L_4, L_5, S_1, S_2 (S_3); they pass through the foramen ischiadicum majus upon the dorsal surface of the spina ischiadica and there divide into two trunks: the medial gives branches to the m. gemellus superior (L_5, S_1, S_2, $[S_3]$) and passes lateral of the a. pudenda interna through the foramen ischiadicum minus to the medial surface of the m. obturator internus (L_5, S_1, S_2, $[S_3]$), the lateral runs upon the capsule of the hip-joint, to which it gives branches, distalward to the mm. gemellus inferior (L_4, L_5, S_1) and quadratus femoris (L_4, L_5, S_1).

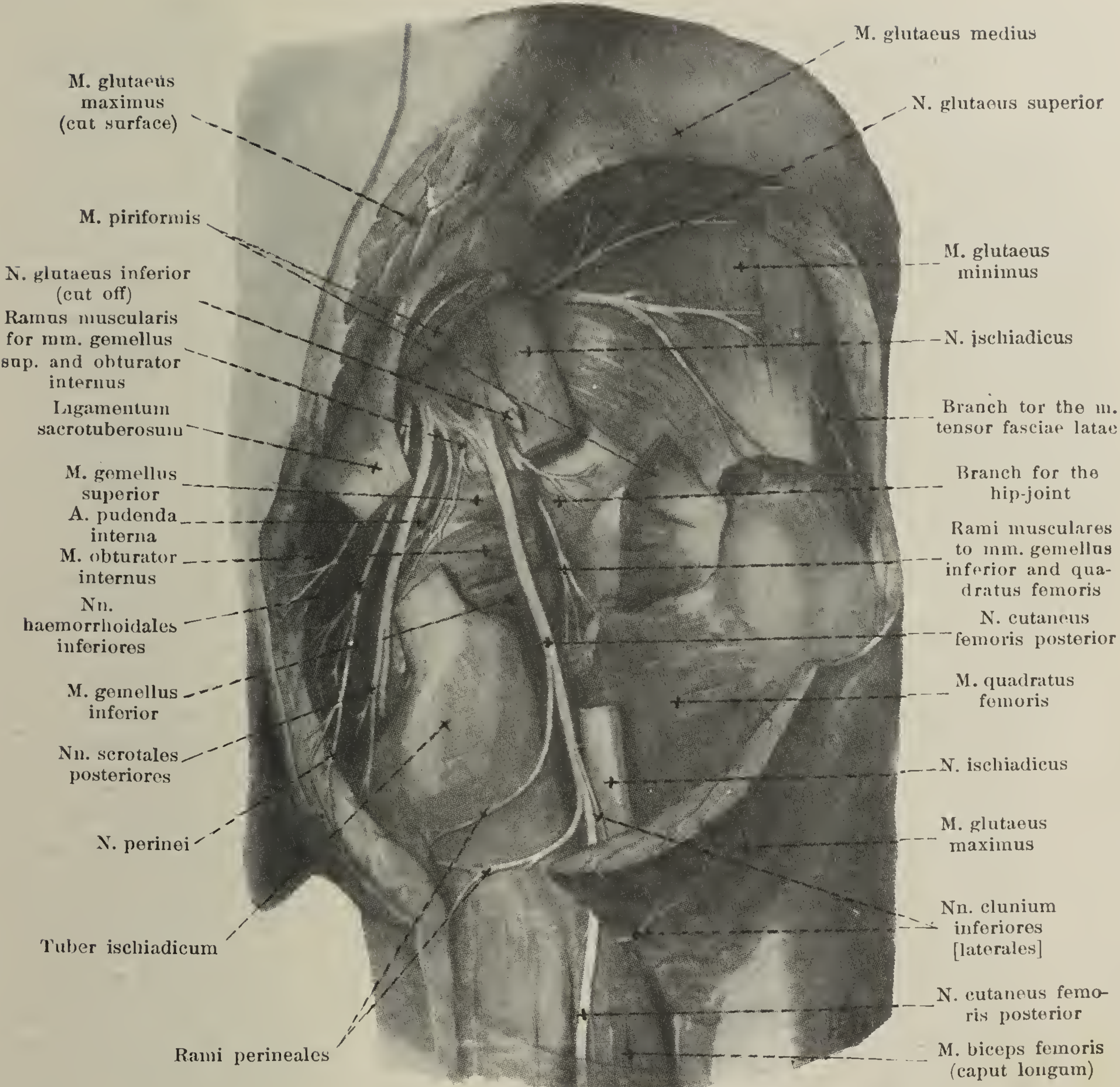
2. *N. glutaeus superior* (see Figs. 870, 871, 877 and 878), from L_4, L_5, S_1 (S_2), runs lateralward above the m. piriformis (not rarely by one bundle through it) lateral from, and below the a. glutaea superior through (the foramen suprapiriforme of) the foramen ischiadicum majus and then between the mm. glutaei medius and minimus; it supplies these and, usually partly perforating the m. glutaeus minimus, sends a twig into the medial surface of the m. tensor fasciae latae.

3. *N. glutaeus inferior* (see Figs. 870, 877 and 878), from (L_4), L_5, S_1 and S_2, passes in front of the distal margin of the m. piriformis between it and the n. ischiadicus, lateral from the a. glutaea inferior through (the foramen infrapiriforme of) the foramen ischiadicum majus and enters the anterior surface of the m. glutaeus maximus.


Ganglia lumbalia
Corpus vertebrae lumbalis IV
A. iliaca communis dextra
Fascia iliaca
M. psoas major
Truncus lumbosacralis
A. hypogastrica
A. glutaea superior
N. cutaneus femoris lateralis
A. iliaca externa
N. obturatorius
Plexus sacralis
A. obturatoria
V. iliaca externa
M. obturator internus with fascia obturatoria
Arcus tendineus m. levatoris ani
M. levator ani
Symphysis ossium pubis
Lig. suspensorium penis
N. dorsalis penis (dexter)
Proc. spinosus vertebrae lumbalis IV
Ramus anterior n. lumbalis IV
Plexus lumbalis
Ramus anterior n. lumbalis V
Truncus lumbosacralis
Promontorium
Facies auricularis oss. sacri
Ramus anterior n. sacralis I
M. piriformis
Rami musculares for the m. piriformis
Ganglia sacralia
A. glutaea inferior
Plexus pudendus
Ramus muscularis for the m. coccygeus
Rami viscerales
Plexus coccygeus
Ramus anterior n. coccygei
M. coccygeus
N. pudendus
A. pudenda interna
Ramus muscularis for the m. levator ani
N. perinei
Fascia obturatoria
N. dorsalis penis (dexter)
Trigonum urogenitale
N. dorsalis penis (sinister)
Nn. scrotales anteriores (sinistri)
M. bulbocavernosus
Corpus cavernosum penis

876. Nerves of the right half of the pelvis, viewed from the left.

(The viscera have been removed, the fascia pelvis has been completely, the fascia iliaca partly, removed. Of the m. levator ani only the lateral part has been preserved; a piece has been cut out of the fascia obturatoria.)


M. glutaeus maximus (cut surface)
M. piriformis
N. glutaeus inferior (cut off)
Ramus muscularis for mm. gemellus sup. and obturator internus
Ligamentum sacrotuberosum
M. gemellus superior
A. pudenda interna
M. obturator internus
Nn. haemorrhoidales inferiores
M. gemellus inferior
Nn. scrotales posteriores
N. perinei
Tuber ischiadicum
Rami perineales
M. glutaeus medius
N. glutaeus superior
M. glutaeus minimus
N. ischiadicus
Branch for the m. tensor fasciae latae
Branch for the hip-joint
Rami musculares to mm. gemellus inferior and quadratus femoris
N. cutaneus femoris posterior
M. quadratus femoris
N. ischiadicus
M. glutaeus maximus
Nn. clunium inferiores [laterales]
N. cutaneus femoris posterior
M. biceps femoris (caput longum)

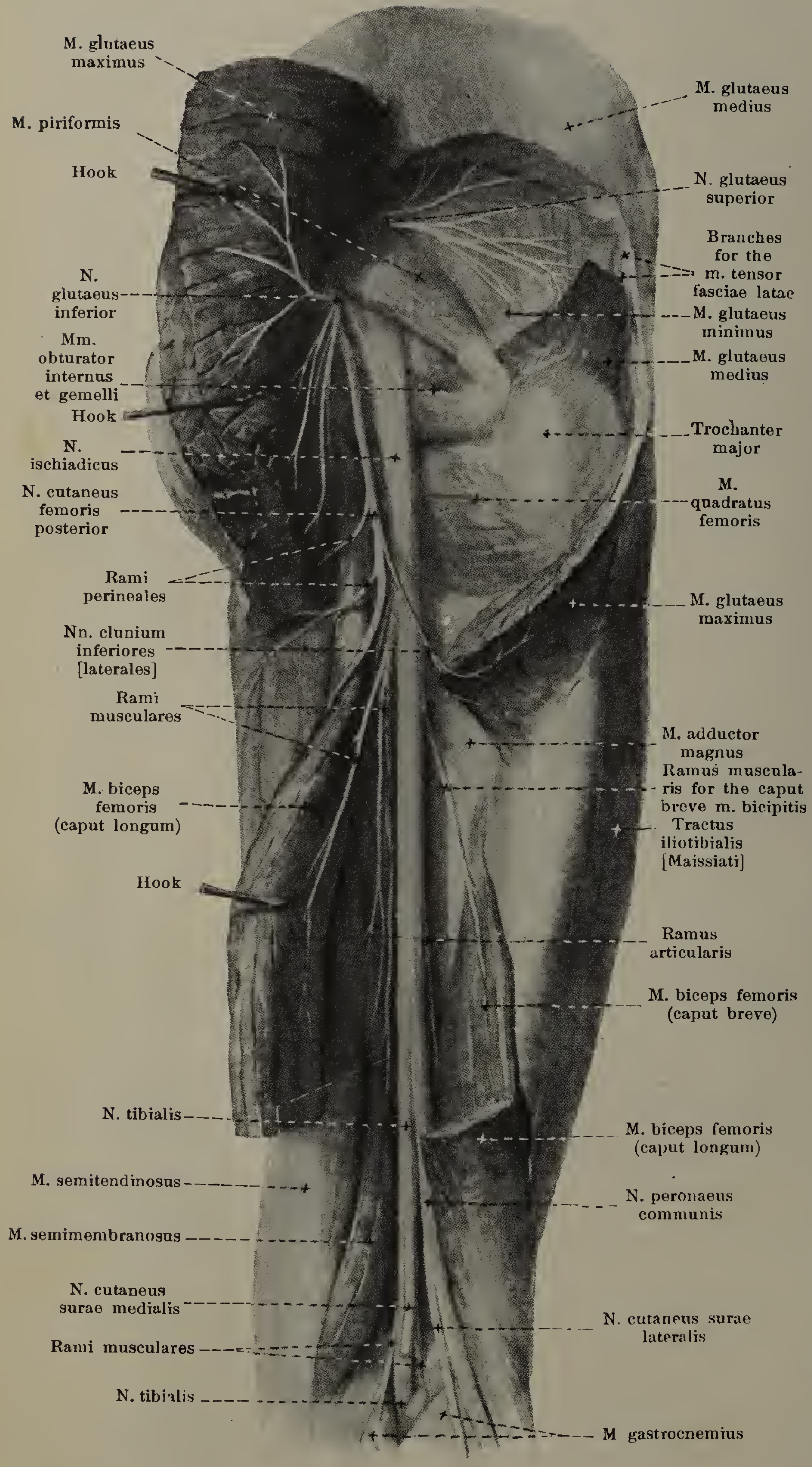
877. Deep nerves of the right buttock, viewed from behind. (The mm. glutaei maximus and medius, piriformis, obturatores and gemelli, as well as the lig. sacrotuberosum have been partially removed; a piece has been cut out of the n. ischiadicus.)

B. Branches to the lower extremity:

4. *N. cutaneus femoris posterior* (O. T. small sciatic) (see also Figs. 870, 871, 878—880 and 886—888), from S_1, S_2 and S_3, runs through the foramen ischiadicum majus under the distal margin of the m. piriformis (through the foramen infrapiriforme), behind the n. ischiadicus, lateral from the a. and v. glutaea inferior and goes distalward directly in front of the m. glutaeus maximus somewhat medially from the middle between the tuber ischiadicum and the trochanter major. It then crosses at a sharp angle the dorsal surface of the caput longum m. bicipitis and runs farther in the groove between the mm. semitendinosus and biceps under the fascia lata into the popliteal space. It sends larger, medial and smaller, lateral branches, which are shorter above, longer below, through the fascia to the skin of the posterior surface of the thigh and of the calf; in addition:

a) *Nn. clunium inferiores [laterales],* two or three, arise in front of the m. glutaeus maximus, loop around its distal margin to its dorsal surface and go cranialward to the skin over the lateral part of the buttock.

b) *Rami perineales,* usually two, arise at the same level as the preceding, run at first downward in front of the m. glutaeus maximus, then close under the tuber ischiadicum medianward upon the muscles springing from it, and go through the fascia lata to the skin of the uppermost part of the medial surface of the thigh, of the perineum and to the posterior surface of the scrotum (labium majus in the female); they anastomose there with the nn. scrotales (labiales) posteriores.



878.
Nerves of the right thigh,
viewed from behind.

(The m. glutaeus maximus and the caput longum m. bicipitis femoris have been cut through and drawn to the side; a piece has been cut out of the m. glutaeus medius.)

5. *N. ischiadicus* (see also Figs. 870, 871, 877, 881 and 887), the largest nerve of the body, is a flattened cord which passes under (very rarely through) the m. piriformis lateral from the a. glutaea inferior (see also Fig. 528) through (the foramen infrapiriforme of) the foramen ischiadicum majus and thence passes almost vertically downward behind the mm. gemelli, the tendon of the m. obturator internus and the m. quadratus femoris, medially from the middle between the trochanter major and the tuber ischiadicum, in front of the n. cutaneus femoris posterior and the m. glutaeus maximus. It then runs on the posterior surface of the m. adductor magnus in front of the caput longum m. bicipitis as far as the upper apex of the popliteal space and there divides into the *n. tibialis* and the *n. peronaeus communis.* In about 15% of the cases this division occurs as high up as the plexus itself, in which event the n. peronaeus runs through the m. piriformis, the n. tibialis below it. In the other cases this separation can be easily brought about artificially, and thus it is easy to establish whether the branches which go off to the thigh from the n. ischiadicus belong really to the n. tibialis or to the n. peronaeus communis. Branches:

879.

Cutaneous nerves of the right thigh,

viewed from behind.

(The fascia lata except for a middle strip has been preserved.)

A. Branches in the thigh:

a) Belonging to the n. tibialis (from its ventral surface):

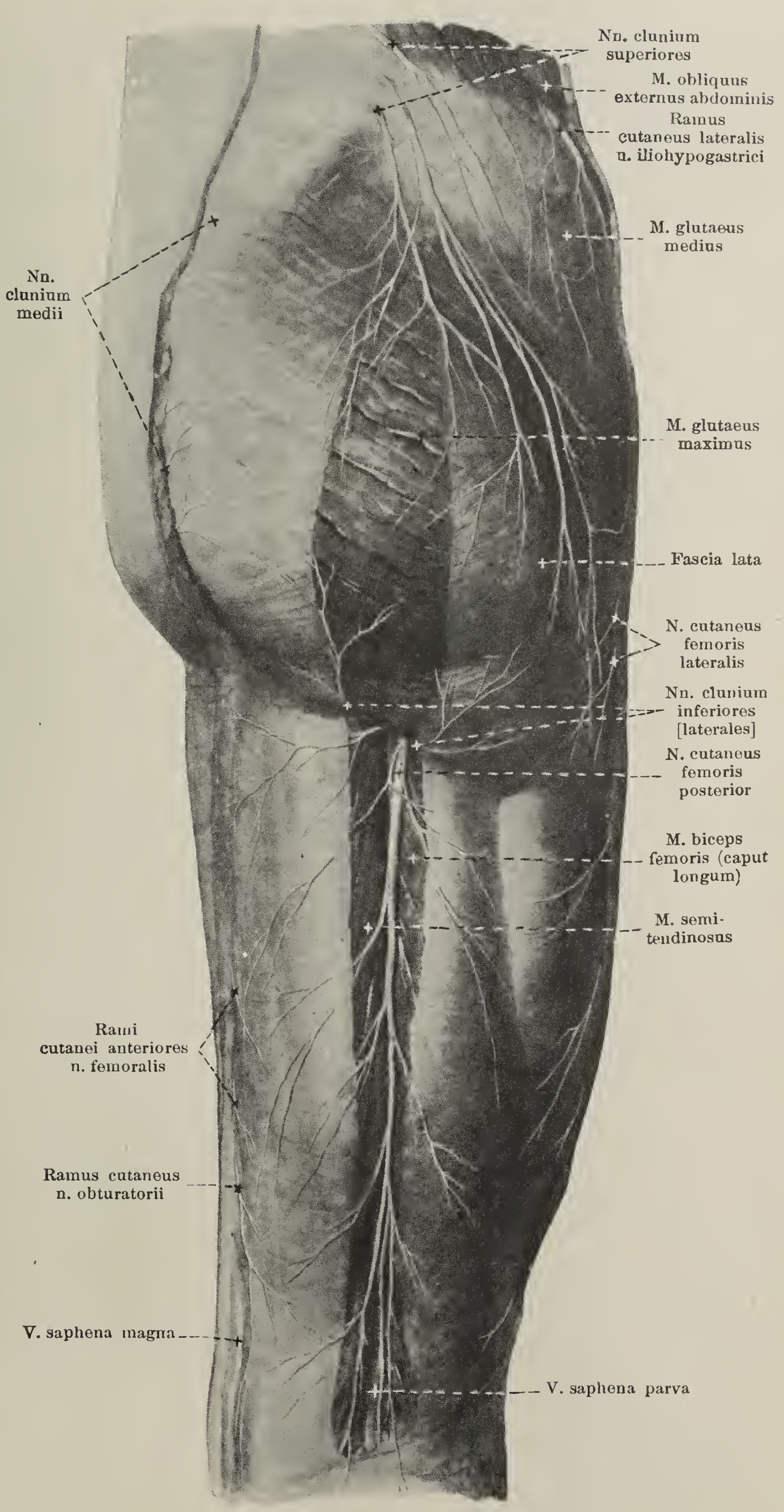
Rami musculares (see Fig. 878), from L_4, L_5, S_1, S_2 and S_3, for the m. semitendinosus (an upper from S_1, S_2 and a lower from L_4, L_5, S_1), for the caput longum m. bicipitis from (L_5), S_1, S_2, S_3, the m. semimembranosus from (L_4), L_5, S_1 and for the dorsal part of the m. abductor magnus from L_4, L_5.

b) Belonging to the n. peronaeus:

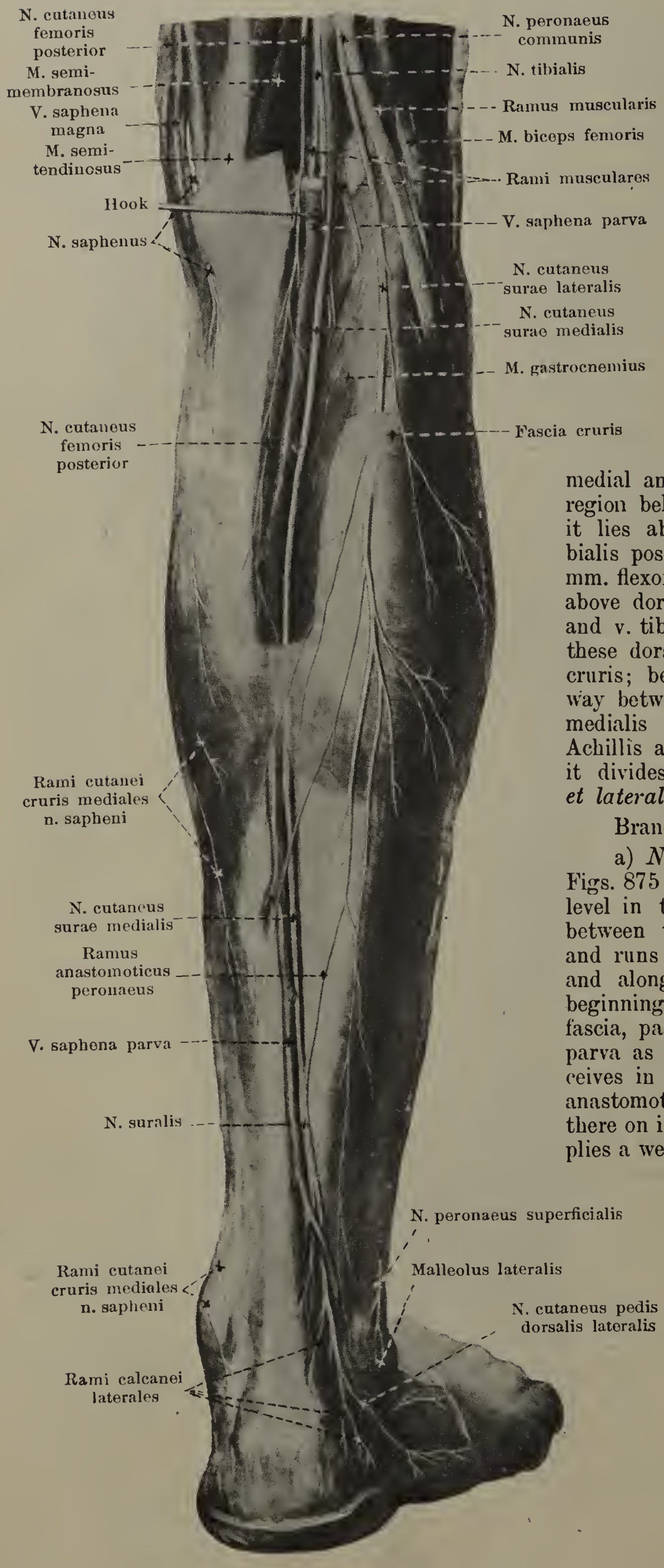
Ramus muscularis (see Fig. 878) from L_4, L_5 and S_1, for the caput breve m. bicipitis.

Ramus articularis downward to the capsule of the knee-joint.

B. *N. tibialis* (see Figs. 870, 878, 880—883, 885 and 886), from L_4, L_5, S_1, S_2 and S_3, runs almost perpendicularly from the upper to the lower angle of the popliteal space and passes between the two heads of the m. gastrocnemius into the depth, behind the m. popliteus and in front of the tendinous arch in the origin of the m. soleus.


Nn. clunium superiores
M. obliquus externus abdominis
Ramus cutaneus lateralis n. iliohypogastrici
M. glutaeus medius
Nn. clunium medii
M. glutaeus maximus
Fascia lata
N. cutaneus femoris lateralis
Nn. clunium inferiores [laterales]
N. cutaneus femoris posterior
M. biceps femoris (caput longum)
M. semitendinosus
Rami cutanei anteriores n. femoralis
Ramus cutaneus n. obturatorii
V. saphena magna
V. saphena parva

880.
Cutaneous nerves of the right leg,
viewed from behind.


N. cutaneus femoris posterior
M. semimembranosus
V. saphena magna
M. semitendinosus
Hook
N. saphenus
N. peronaeus communis
N. tibialis
Ramus muscularis
M. biceps femoris
Rami musculares
V. saphena parva
N. cutaneus surae lateralis
N. cutaneus surae medialis
M. gastrocnemius
Fascia cruris
N. cutaneus femoris posterior
Rami cutanei cruris mediales n. sapheni
N. cutaneus surae medialis
Ramus anastomoticus peronaeus
V. saphena parva
N. suralis
N. peronaeus superficialis
Malleolus lateralis
Rami cutanei cruris mediales n. sapheni
N. cutaneus pedis dorsalis lateralis
Rami calcanei laterales

(The fascia has been preserved, except for its upper part.)

B. *N. tibialis* (continued) (see also Figs. 878, 881—883, 885 and 886): In the popliteal space it lies directly beneath the fascia, dorsal and lateral from the v. poplitea, which itself runs dorsal and lateral from the a. poplitea; below it is separated from the m. popliteus by the vessels. In the leg it descends above in front of the middle of the m. soleus, below medial and in front of the tendo Achillis to the region behind the medial malleolus; in this course it lies above on the dorsal surface of the m. tibialis posterior, below in the groove between the mm. flexores digitorum longus and hallucis longus, above dorsalward elsewhere lateralward from the a. and v. tibialis posterior, being covered along with these dorsalward by the deep layer of the fascia cruris; below the nerve runs approximately midway between the posterior margin of the malleolus medialis and the medial margin of the tendo Achillis and at the same time behind the vessels; it divides there into the *nn. plantares medialis et lateralis.*

Branches in the popliteal space:

a) *N. cutaneus surae medialis* (see also Figs. 875, 881 and 884—886) arises at a variable level in the popliteal space, goes to the groove between the two bellies of the m. gastrocnemius and runs downward in it beneath the fascia cruris and along with the v. saphena parva. At the beginning of the tendo Achillis it perforates the fascia, passes upon it lateral from the v. saphena parva as far as behind the malleolus lateralis, receives in its course at a variable level the ramus anastomoticus peronaeus (see p. 782) and from there on is called the *n. suralis.* In the leg it supplies a wedged-shaped distal portion of the dorsal and lateral surfaces (see Fig. 886) and gives off *rami calcanei laterales* to the dorsal and lateral portions of the skin of the heel. It then runs forward in front of the v. saphena parva, passing in a curve behind and below the lateral malleolus, anastomoses with the n. cutaneus dorsalis intermedius (see Fig. 875) and goes as the *n. cutaneus dorsalis pedis lateralis* (see also Figs. 875 and 884) along the lateral margin of the foot as far as the base of the terminal phalanx of the 5th toe, in order usually to break up on the lateral margin of this toe, more rarely also on the dorsal surfaces of the 4th and half of the 3rd toe.

881. Muscle nerves of the right leg,

viewed from behind.

(The mm. semitendinosus, semimembranosus, biceps, gastrocnemius, plantaris, soleus and flexor hallucis longus have been wholly or partly removed.)

B. *N. tibialis* (continued):

b) ***Rami musculares*** (see also Figs. 878 and 880) to the two heads of the m. gastrocnemius from S_1, S_2, to the mm. plantaris from L_5, S_1, S_2, soleus from L_5, S_1, S_2 and popliteus from L_4, L_5, S_1.

c) ***Rami articulares*** to the knee-joint.

d) ***N. interosseus cruris*** (see also Fig. 884) passes distalward near the a. tibialis anterior inside the membrana interossea cruris and gives branches to the vessels, bones and syndesmosis tibiofibularis.

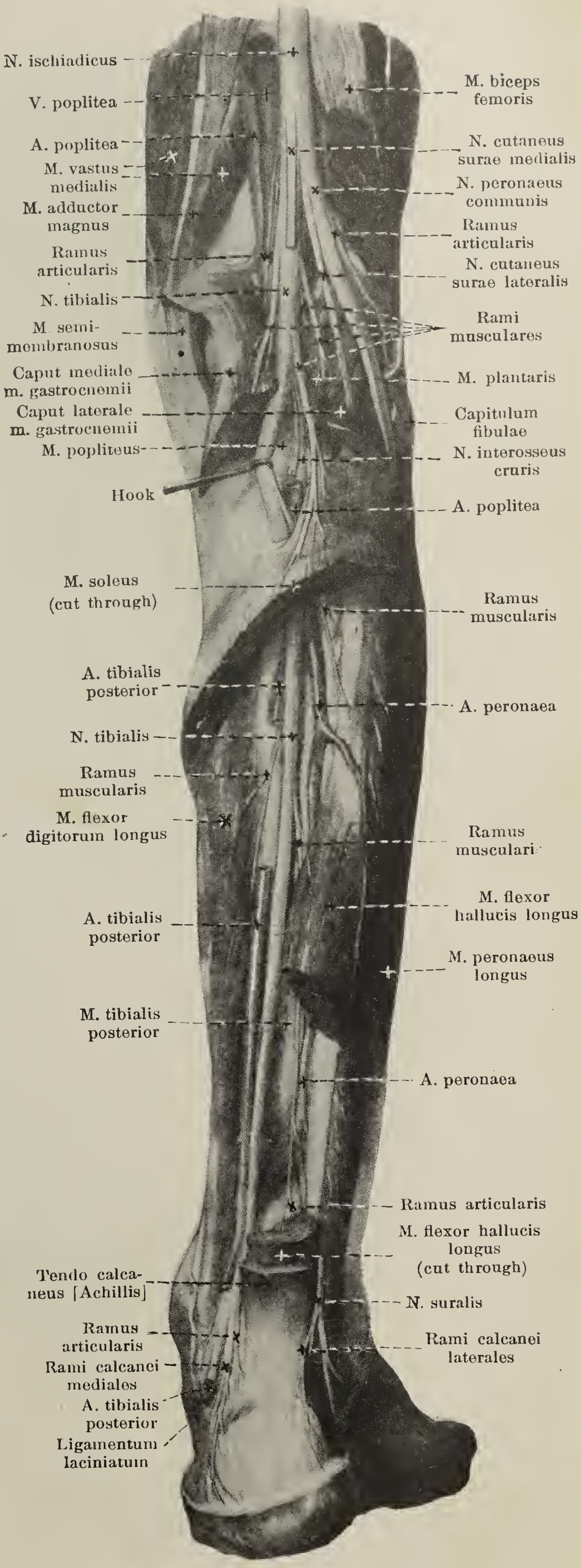
Branches in the leg:

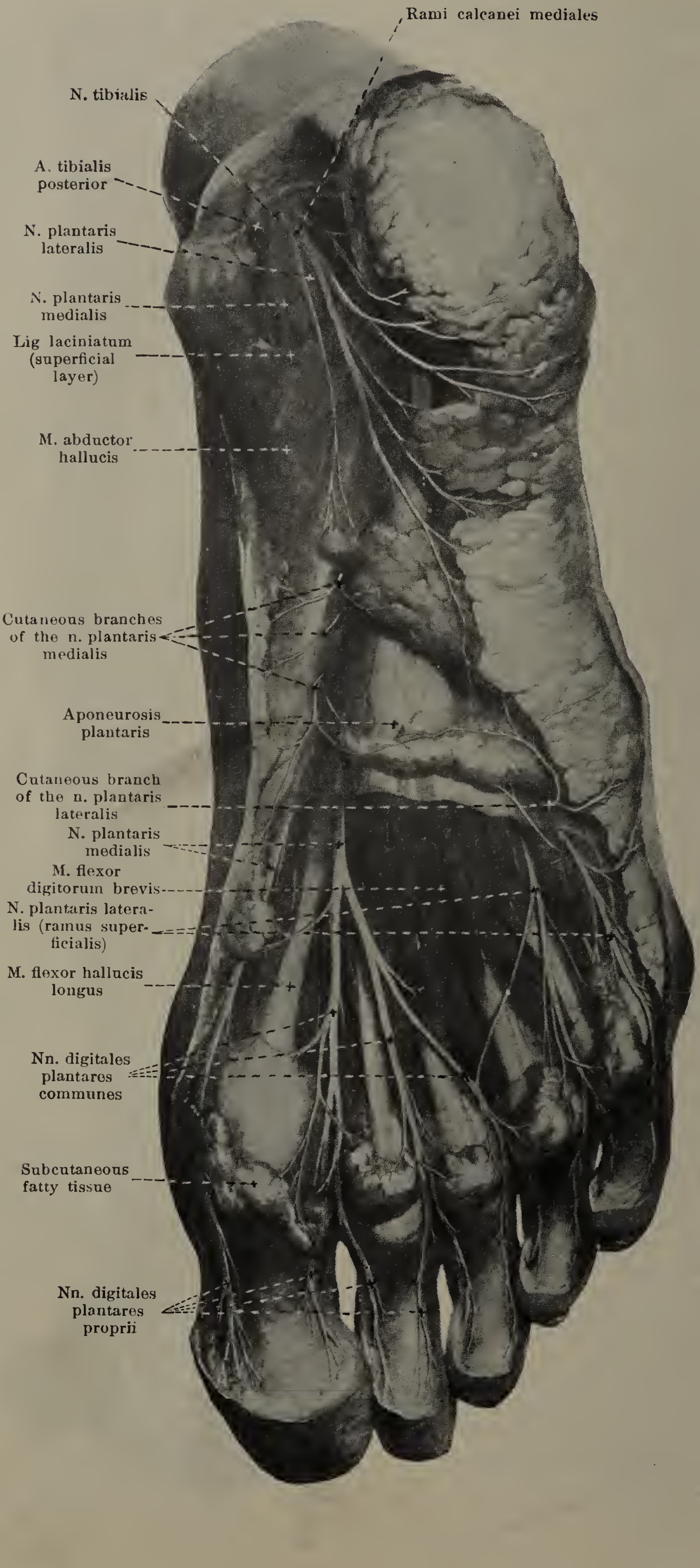
e) ***Rami musculares*** to the mm. tibialis posterior from L_5, S_1, flexor digitorum longus from L_5, S_1 and flexor hallucis longus from L_5, S_1, S_2.

f) ***Rami articulares***, partly from e) to the ankle joint.

g) ***Rami calcanei mediales*** (see also Figs. 882, 885 and 886), frequently going off from a trunk in the lower third of the leg, extend to the skin on the posterior medial surface of the heel and on the posterior part of the sole of the foot; they anastomose with branches of the nn. suralis and plantares.

h) ***N. plantaris medialis*** (see Figs. 882 and 883), the larger terminal branch, runs at first between the two layers of the lig. laciniatum (in the upper compartment, see p. 379), then on the lateral surface of the m. abductor hallucis and arrives on the lower surface of the tendon of the m. flexor digitorum longus and finally on the medial surface of the m. flexor digitorum brevis, crossed by the vessels more superficially situated. In its course it gives off small branches (see Fig. 882) to the skin of the medial portion of the hollow of the foot, as well as *rami musculares* (see Fig. 883) to the mm. flexor digitorum brevis (bellies of 2nd to 4th toe) (L_5, S_1), abductor hallucis (L_5, S_1) and flexor hallucis brevis (L_5, S_1). It then sends (see Figs. 882 and 883) a ***n. digitalis plantaris proprius*** to the medial margin of the plantar surface of the great toe, which also sends a branch to the medial head of the m. flexor hallucis brevis, and divides into three ***nn. digitales plantares communes,*** which pass distalward between the m. flexor digitorum brevis and the aponeurosis plantaris of the 1st—3rd spatium interosseum and divide at the level of the articulationes metatarsophalangeae, each into two ***nn. digitales plantares proprii.*** The latter supply the adjacent sides of the volar surfaces of the 1st—4th toe, as well as the dorsal surfaces of the corresponding terminal phalanges. The first n. digitalis plantaris communis sends also a small branch to the m. lumbricalis I (L_5, S_1), and the third often receives an anastomosis from the n. plantaris lateralis (see p. 781).




Rami calcanei mediales
N. tibialis
A. tibialis posterior
N. plantaris lateralis
N. plantaris medialis
Lig laciniatum (superficial layer)
M. abductor hallucis
Cutaneous branches of the n. plantaris medialis
Aponeurosis plantaris
Cutaneous branch of the n. plantaris lateralis
N. plantaris medialis
M. flexor digitorum brevis
N. plantaris lateralis (ramus superficialis)
M. flexor hallucis longus
Nn. digitales plantares communes
Subcutaneous fatty tissue
Nn. digitales plantares proprii

882.
Cutaneous nerves of the sole of the right foot,

viewed from below.

(The aponeurosis plantaris has been removed in front.)

B. *N. tibialis* (continued):

i) *N. plantaris lateralis* (see also Fig. 883) lies at first between the two layers of the lig. laciniatum (in the lower compartment, see p. 379), then runs distalward and lateralward between the mm. flexor digitorum brevis and quadratus plantae, gives off as it goes *rami musculares* to the mm. flexor digitorum brevis (belly of 5th toe) (S_1, S_2), quadratus plantae (S_1, S_2) and abductor digiti V (S_1, S_2) and divides into a *ramus profundus* and a *ramus superficialis.*

α) *Ramus profundus* goes into the depth with the arcus plantaris and runs medianward on the dorsal surface of the m. quadratus plantae and of the caput obliquum m. adductoris hallucis, between it and the mm. interossei. It gives branches to the joints as well as *rami musculares* to the mm. interossei of the 1st—3rd spatium interosseum (S_1, S_2), to the mm. lumbricales II to IV (S_1, S_2), the m. adductor hallucis (S_1, S_2) and rarely to the lateral belly of the m. flexor hallucis brevis (S_1, S_2).

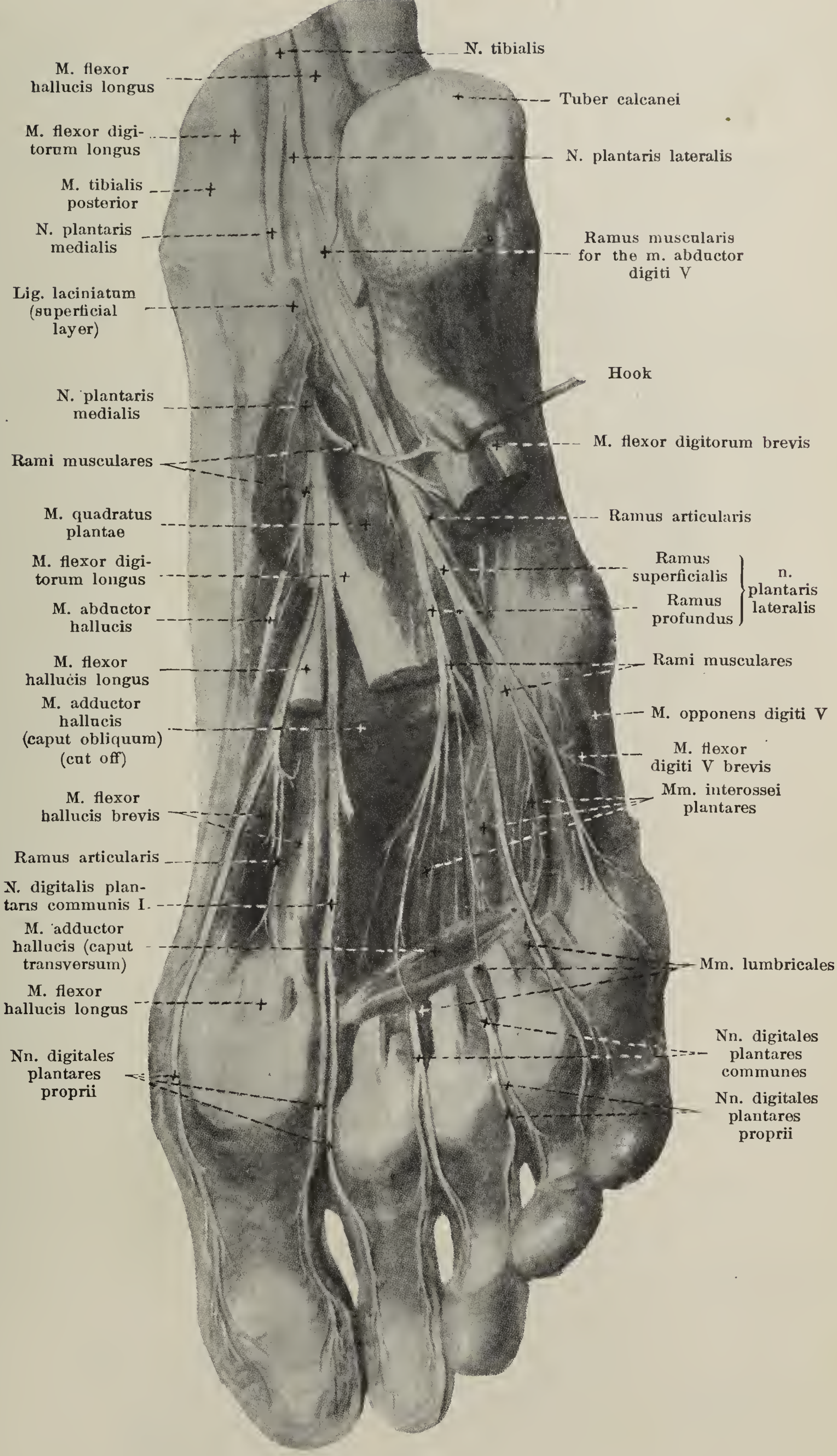
883. Deep nerves of the sole of the right foot,

viewed from below.

(The muscles of the toes have been partially removed.)

i) *N. plantaris lateralis* (continued) (see also Fig. 882):

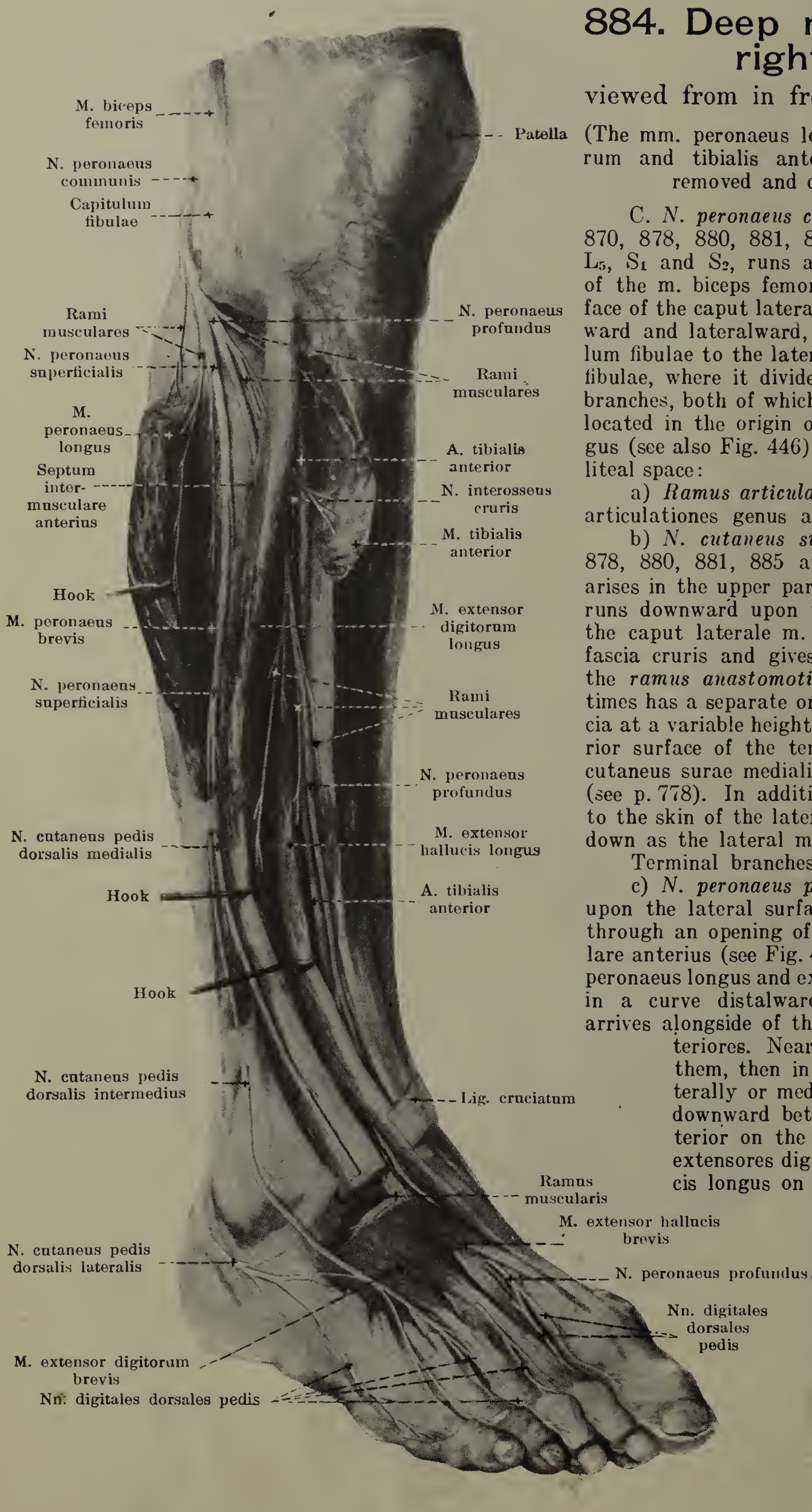
β) ***Ramus superficialis*** divides at the lateral margin of the m. flexor digitorum brevis into a medial and a lateral branch. The medial *n. digitalis plantaris communis IV* runs distalward upon the 4th spatium interosseum, sends an anastomosis to the n. plantaris medialis (see p. 779) and divides into two *nn. digitales plantares proprii* for the adjacent sides of the volar surfaces of the 4th and 5th toe and for the dorsal surfaces of the terminal phalanges. The lateral branch runs as a *n. digitalis plantaris proprius* along the surface of the m. flexor digiti V brevis distalward and lateralward to the lateral margin of the 5th toe; in its course it gives off *rami musculares* to the mm. flexor digiti V brevis (S_1, S_2) and opponens digiti V (S_1, S_2) and the mm. interossei of the 4th spatium interosseum (S_1, S_2).


M. flexor hallucis longus
M. flexor digitorum longus
M. tibialis posterior
N. plantaris medialis
Lig. laciniatum (superficial layer)
N. plantaris medialis
Rami musculares
M. quadratus plantae
M. flexor digitorum longus
M. abductor hallucis
M. flexor hallucis longus
M. adductor hallucis (caput obliquum) (cut off)
M. flexor hallucis brevis
Ramus articularis
N. digitalis plantaris communis I
M. adductor hallucis (caput transversum)
M. flexor hallucis longus
Nn. digitales plantares proprii
N. tibialis
Tuber calcanei
N. plantaris lateralis
Ramus muscularis for the m. abductor digiti V
Hook
M. flexor digitorum brevis
Ramus articularis
Ramus superficialis
Ramus profundus
n. plantaris lateralis
Rami musculares
M. opponens digiti V
M. flexor digiti V brevis
Mm. interossei plantares
Mm. lumbricales
Nn. digitales plantares communes
Nn. digitales plantares proprii

884. Deep nerves of the right leg,

viewed from in front and lateralward.

(The mm. peronaeus longus, extensores digitorum and tibialis anterior have been partly removed and drawn asunder.)


M. biceps femoris
N. peronaeus communis
Capitulum fibulae
Rami musculares
N. peronaeus superficialis
M. peronaeus longus
Septum intermusculare anterius
Hook
M. peronaeus brevis
N. peronaeus superficialis
N. cutaneus pedis dorsalis medialis
Hook
Hook
N. cutaneus pedis dorsalis intermedius
N. cutaneus pedis dorsalis lateralis
M. extensor digitorum brevis
Nn. digitales dorsales pedis
Patella
N. peronaeus profundus
Rami musculares
A. tibialis anterior
N. interosseus cruris
M. tibialis anterior
M. extensor digitorum longus
Rami musculares
N. peronaeus profundus
M. extensor hallucis longus
A. tibialis anterior
Lig. cruciatum
Ramus muscularis
M. extensor hallucis brevis
N. peronaeus profundus
Nn. digitales dorsales pedis

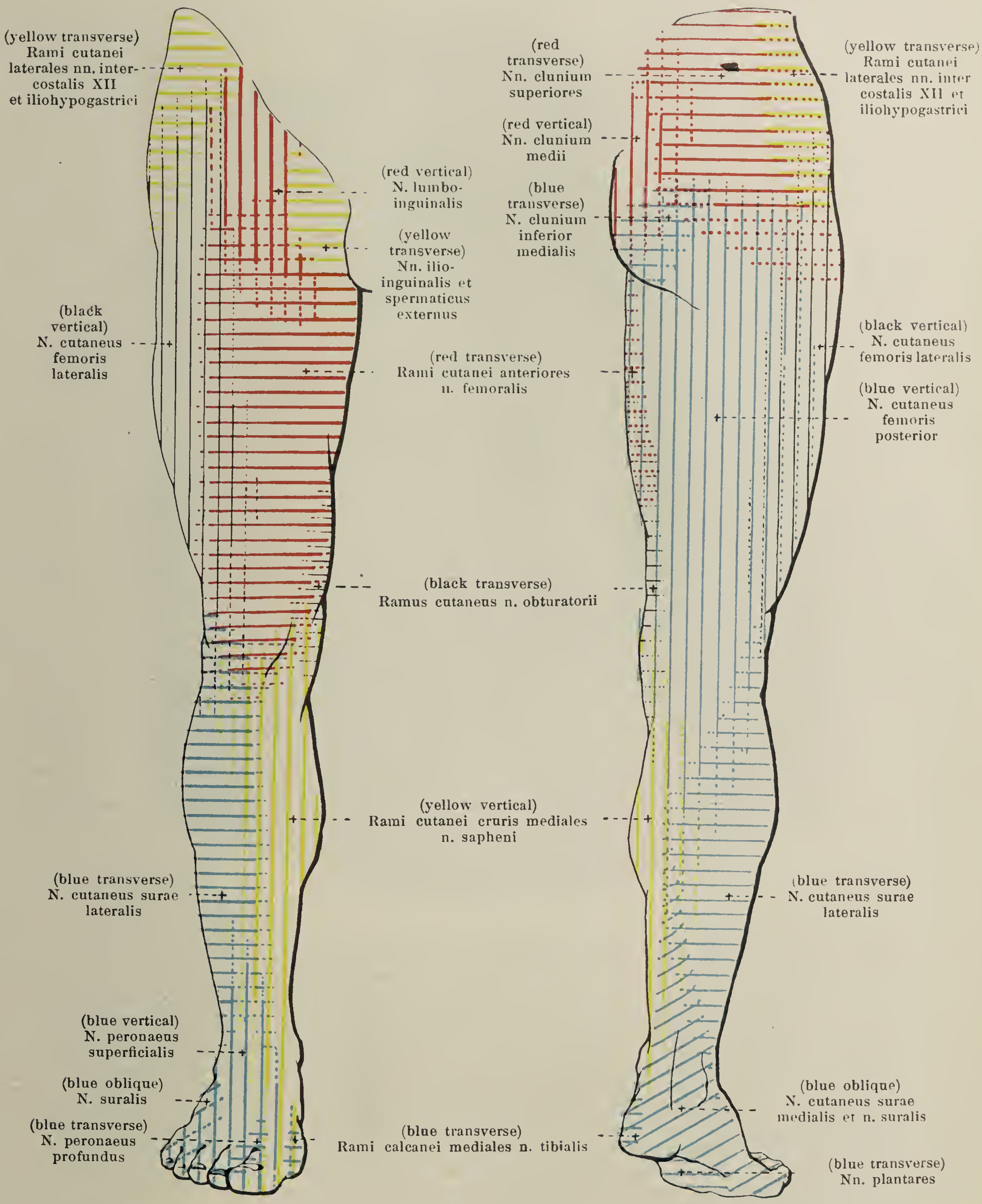
C. *N. peronaeus communis* (see also Figs. 870, 878, 880, 881, 885 and 886), from L_4, L_5, S_1 and S_2, runs along the medial margin of the m. biceps femoris upon the dorsal surface of the caput laterale m. gastrocnemii distalward and lateralward, then behind the capitulum fibulae to the lateral margin of the collum fibulae, where it divides into its two terminal branches, both of which pass through the canal located in the origin of the m. peronaeus longus (see also Fig. 446). It gives off in the popliteal space:

a) *Ramus articularis* (see Fig. 881) to the articulationes genus and tibiofibularis.

b) *N. cutaneus surae lateralis* (see Figs. 878, 880, 881, 885 and 886), very variable, arises in the upper part of the popliteal space, runs downward upon the posterior surface of the caput laterale m. gastrocnemii, under the fascia cruris and gives off at a variable level the *ramus anastomoticus peronaeus* (it sometimes has a separate origin), perforates the fascia at a variable height and unites on the posterior surface of the tendo Achillis with the n. cutaneus surae medialis to form the *n. suralis* (see p. 778). In addition it gives off branches to the skin of the lateral half of the leg as far down as the lateral malleolus.

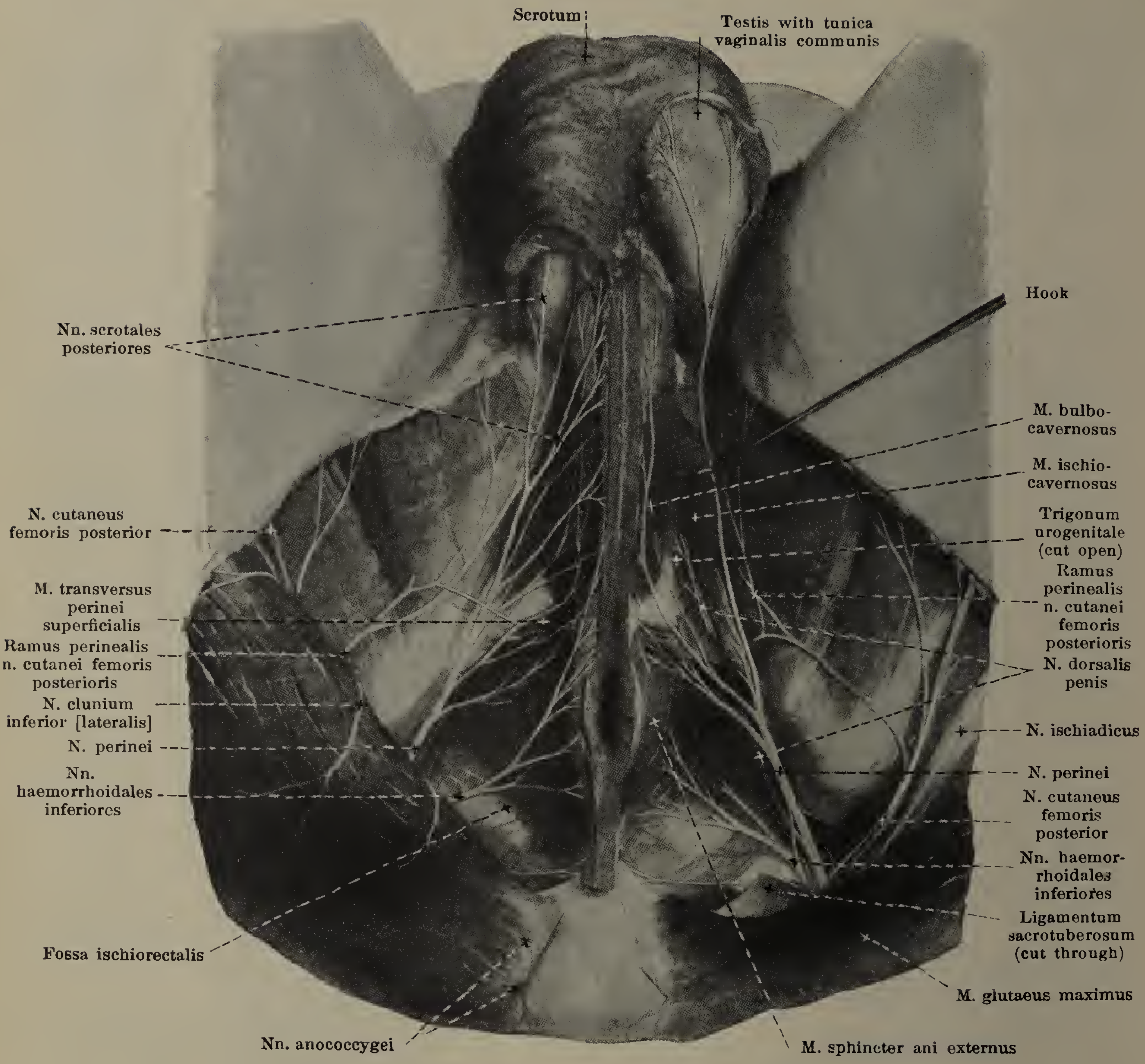
Terminal branches:

c) *N. peronaeus profundus* passes directly upon the lateral surface of the collum fibulae through an opening of the septum intermusculare anterius (see Fig. 443), covered by the mm. peronaeus longus and extensor digitorum longus, in a curve distalward and medianward and arrives alongside of the a. and vv. tibiales anteriores. Near these, first lateral from them, then in front of, and finally laterally or medially from them, it runs downward between the m. tibialis anterior on the one hand, and the mm. extensores digitorum longus and hallucis longus on the other, passes behind the ligg. transversum and cruciatum cruris (and behind the tendon of the m. extensor hallucis longus) upon the dorsum of the foot and there passes at first between the mm. extensores hallucis longus and brevis, then behind the tendon of the latter to the first spatium interosseum.


(yellow transverse) Rami cutanei laterales nn. intercostalis XII et iliohypogastrici
(red vertical) N. lumbo-inguinalis
(yellow transverse) Nn. ilio-inguinalis et spermaticus externus
(black vertical) N. cutaneus femoris lateralis
(red transverse) Rami cutanei anteriores n. femoralis
(black transverse) Ramus cutaneus n. obturatorii
(yellow vertical) Rami cutanei cruris mediales n. sapheni
(blue transverse) N. cutaneus surae lateralis
(blue vertical) N. peronaeus superficialis
(blue oblique) N. suralis
(blue transverse) N. peronaeus profundus
(blue transverse) Rami calcanei mediales n. tibialis
(red transverse) Nn. clunium superiores
(red vertical) Nn. clunium medii
(blue transverse) N. clunium inferior medialis
(yellow transverse) Rami cutanei laterales nn. inter costalis XII et iliohypogastrici
(black vertical) N. cutaneus femoris lateralis
(blue vertical) N. cutaneus femoris posterior
(blue transverse) N. cutaneus surae lateralis
(blue oblique) N. cutaneus surae medialis et n. suralis
(blue transverse) Nn. plantares

885 and 886. Areas of distribution of the cutaneous nerves in the right lower extremity,
viewed from in front. viewed from behind.

(The areas constantly supplied by the nerves concerned are indicated by solid lines, the areas not constantly supplied, by dotted lines.)

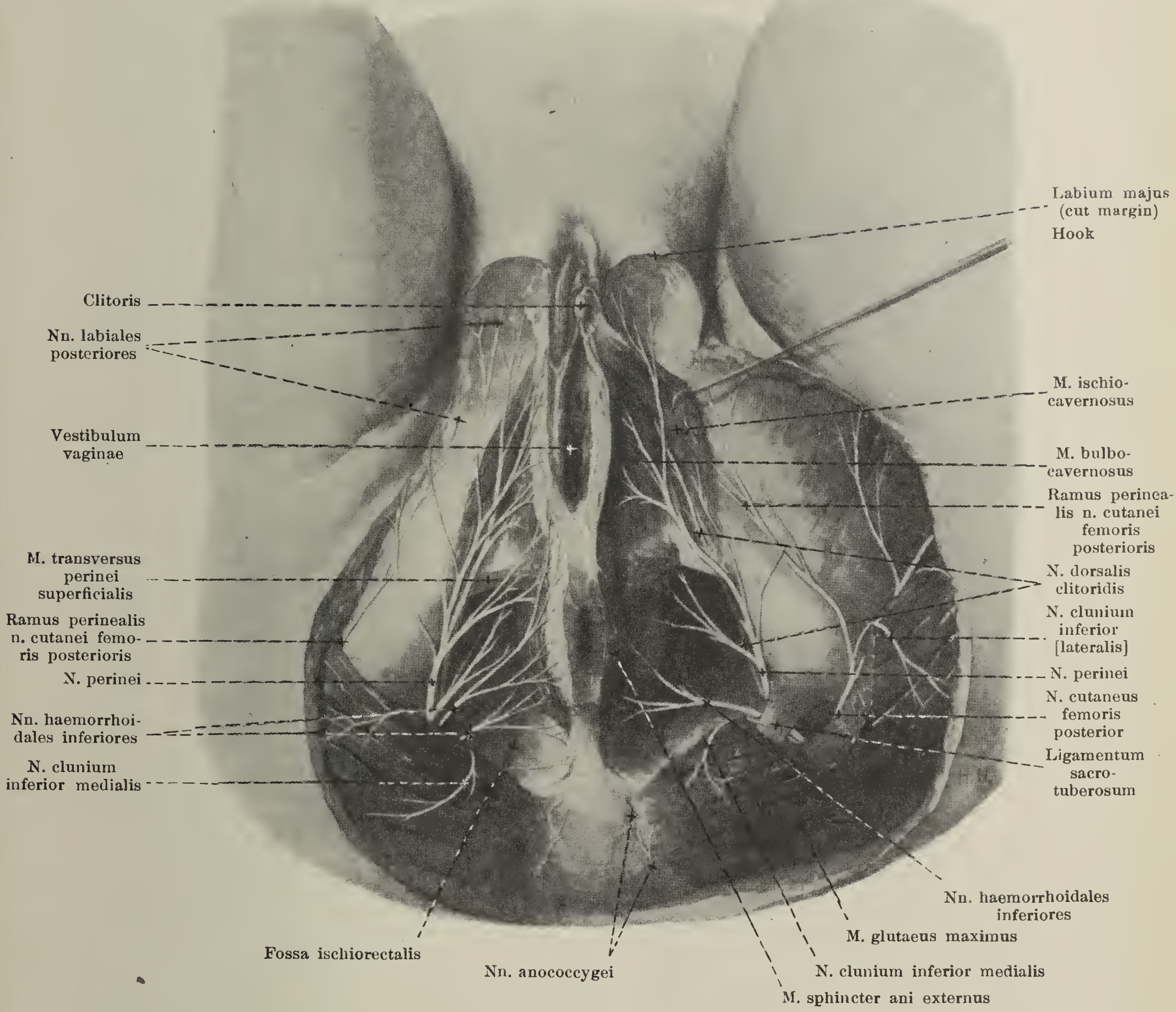

Scrotum
Testis with tunica vaginalis communis
Hook
Nn. scrotales posteriores
M. bulbocavernosus
M. ischiocavernosus
N. cutaneus femoris posterior
Trigonum urogenitale (cut open)
M. transversus perinei superficialis
Ramus perinealis n. cutanei femoris posterioris
Ramus perinealis n. cutanei femoris posterioris
N. dorsalis penis
N. clunium inferior [lateralis]
N. ischiadicus
N. perinei
N. perinei
Nn. haemorrhoidales inferiores
N. cutaneus femoris posterior
Nn. haemorrhoidales inferiores
Ligamentum sacrotuberosum (cut through)
Fossa ischiorectalis
M. glutaeus maximus
Nn. anococcygei
M. sphincter ani externus

887. Nerves of the male perineum, viewed from below. (On the left side parts have been cut out of the lig. sacrotuberosum, of the mm. glutaeus maximus, transversus perinei superficialis and of the trigonum urogenitale. The fascia obturatoria has been removed.)

c) *N. peronaeus profundus* (continued) (see Fig. 884): In the leg it sends ***rami musculares*** to the mm. tibialis anterior (2—3) (L_4, L_5, S_1), extensor digitorum longus (L_4, L_5, S_1) and extensor hallucis longus (L_4, L_5, S_1), as well as a ***ramus articularis*** to the ankle-joint, on the dorsum of the foot a ramus muscularis lateral behind the vessels to the m. extensor digitorum brevis (L_4, L_5, S_1) and then divides into its two terminal branches: ***nn. digitales dorsales hallucis lateralis et digiti secundi medialis*** (see also Figs. 875 and 885), which anastomose with branches of the n. cutaneus dorsalis pedis medialis and supply the adjacent halves of the 1st and 2nd toe as far as the terminal phalanx.

d) *N. peronaeus superficialis* (see Figs. 875, 884 and 885) runs distalward — covered by the m. peronaeus longus — at first on the fibula, then on the lateral anterior surface of the m. peronaeus brevis and as it goes gives off ***rami musculares*** to the mm. peronaei (L_4, L_5, S_1). It then perforates the fascia cruris in the lower half of the leg and divides into two terminal branches.

α) ***N. cutaneus dorsalis pedis intermedius***, the smaller, passes upon the fascia in the direction of the base of the 4th toe, sends branches to the skin of the leg and dorsum of the foot, anastomoses with the n. suralis or its n. cutaneus dorsalis pedis lateralis (see p. 778) and finally divides into four ***nn. digitales dorsales pedis*** for the adjacent halves of the dorsal surfaces of the 3rd—5th toe.


Clitoris
Nn. labiales posteriores
Vestibulum vaginae
M. transversus perinei superficialis
Ramus perinealis n. cutanei femoris posterioris
N. perinei
Nn. haemorrhoidales inferiores
N. clunium inferior medialis
Labium majus (cut margin)
Hook
M. ischiocavernosus
M. bulbocavernosus
Ramus perinealis n. cutanei femoris posterioris
N. dorsalis clitoridis
N. clunium inferior [lateralis]
N. perinei
N. cutaneus femoris posterior
Ligamentum sacrotuberosum
Nn. haemorrhoidales inferiores
M. glutaeus maximus
N. clunium inferior medialis
M. sphincter ani externus
Nn. anococcygei
Fossa ischiorectalis

888. Nerves of the female perineum, viewed from below.

(On the left side pieces have been cut out of the mm. glutaeus maximus, transversus perinei superficialis and the trigonum urogenitale. The fascia obturatoria has been removed.)

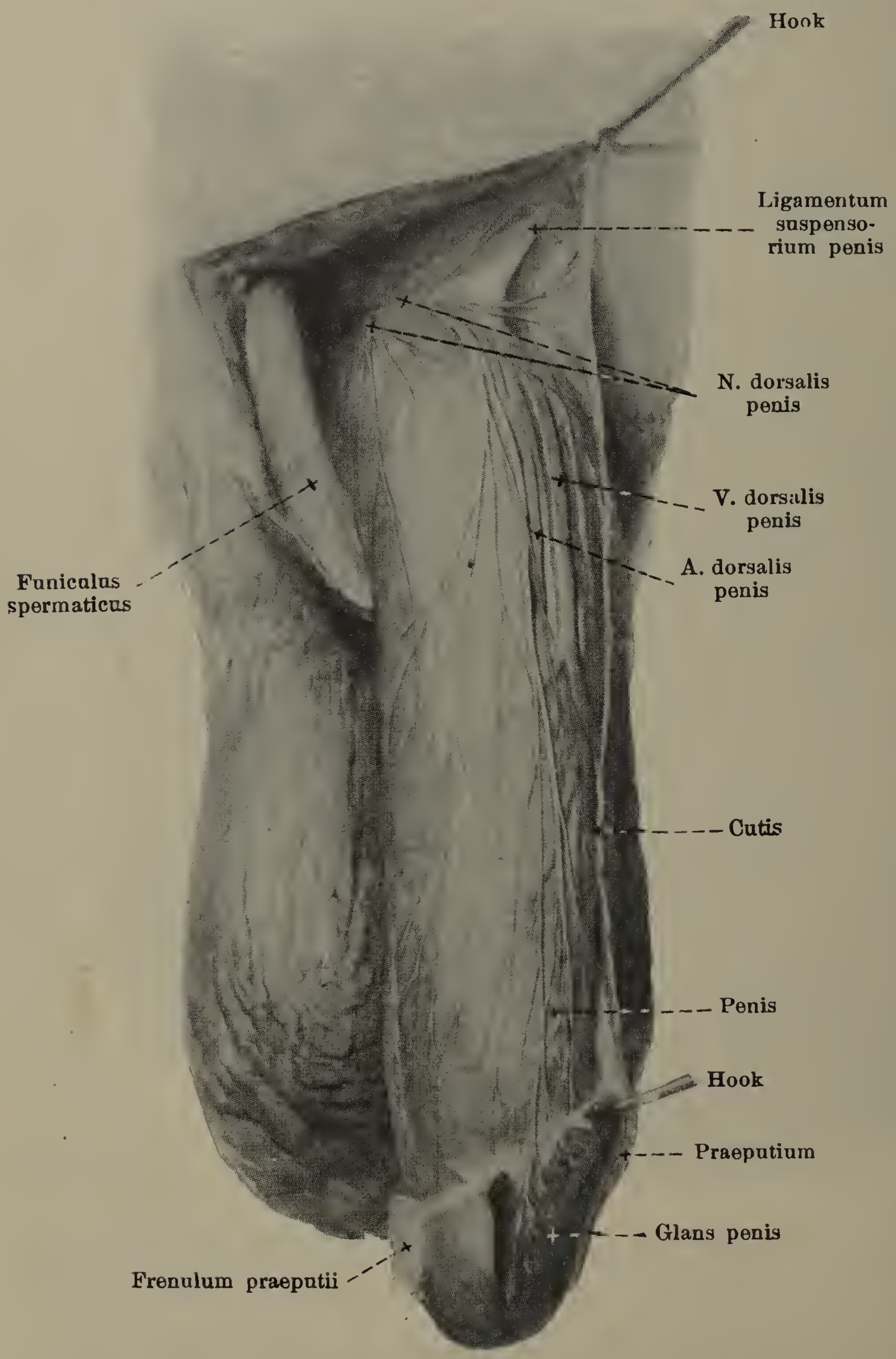
d) *N. peronaeus superficialis* (continued) (see Figs. 875, 884 and 885):

β) ***N. cutaneus dorsalis pedis medialis*** runs upon the fascia cruris distalward and medianward to the dorsum of the foot, gives off branches to the skin of the leg and to the dorsum of the foot and divides into a medial branch, which passes to the medial margin of the foot and of the great toe as far as its terminal phalanx, anastomosing with the n. saphenus and n. peronaeus profundus, and a lateral branch, which goes to the 2nd interosseous space, often anastomoses with the n. peronaeus profundus and divides into two ***nn. digitales dorsales pedis*** for the adjacent halves of the dorsal surfaces of the 2nd and 3rd toe.

7. ***N. clunium inferior medialis*** (see also Figs. 870 and 886), from S_2 and S_3, goes with the n. pudendus through the foramen ischiadicum majus on the back of the spina ischiadica and thence alone in front of or behind the lig. sacrotuberosum, or also through its whole breadth to the inferior margin of the m. glutaeus maximus, passes around the latter and goes upward through the fascia to the skin over the medial part of the buttock.

889. Nerves of the penis, viewed from in front and from the right.

(The skin has been partly removed; the glans has been incised.)



The ***plexus pudendus*** (see Figs. 870 and 876) is formed by the branches of the spinal nerves, which go to the pelvic viscera and to the muscles and skin of the perineum. It is shoved partly in the lower part of the plexus sacralis. Its chief root is S_3; besides it receives contributions from (L_5) S_1, S_2 and S_4. It lies in front of the lowermost parts of the m. piriformis, is crossed in front by the a. and vv. sacrales laterales, and is separated from the ampulla recti by the excavatio rectovesicalis (rectouterina in the female). It gives off the following branches:

1. *Rami musculares* (see Figs. 870, 876 and 892) for the m. levator ani, from (S_2) S_3 and S_4, and the m. coccygeus, from S_3, S_4 (S_5), forward to the inner surface of the same.

2. *Rami viscerales*, 4—6, (see Figs. 876 an 892), from (S_2) S_3 and S_4, run upward on the sides of the pelvic viscera. The go partly directly, partly after union with sympathetic plexuses (see p. 793), to the rectum *(nn. haemorrhoidales medii)*, to the urinary bladder *(nn. vesicales inferiores)* and to the vagina *(nn. vaginales)*.

3. *N. pudendus* (see also Figs. 870, 871, 876, 877, 887, 888 and 892), the largest nerve of the plexus, from (S_1) S_2, S_3 and S_4, runs under the m. piriformis, dorsal- and a little medialward from the a. pudenda interna upon the back of the spina ischiadica, then turns downward, forward and medianward between the fascia obturatoria and the m. obturator internus and divides at the tuber ischiadicum into the *n. perinei* and the *n. dorsalis penis (clitoridis)*. Before division it gives off the *nn. haemorrhoidales inferiores*, from S_3 and S_4, which pass through the fascia obturatoria and medianward and forward through the fossa ischiorectoralis, to supply the m. sphincter ani externus (S_3, S_4) and the skin of the anus and its neighborhood and to anastomose with branches of the n. perinei. Terminal branches:

a) *N. perinei*, from S_2, S_3 and S_4, passes in a curve forward and downward on the medial surface of the tuber ischiadicum, and with its branches perforates the fascia obturatoria behind the trigonum urogenitale; its superficial branches, *nn. scrotales (labiales) posteriores*, go to the skin of the perineum and of the scrotum (labium majus in the female), its deep branches to the mm. transversus perinei superficialis (S_3), bulbocavernosus (S_3) and ischiocavernosus (S_3), as well as into the penis; it anastomoses with the nn. haemorrhoidales inferiores and rami perineales n. cutanei femoris posterioris, as well as with branches of the n. dorsalis penis (see p. 787).

b) *N. dorsalis penis (clitoridis)* (see Figs. 870, 876, 887—889 and 892), from S_2 and S_3, smaller than the n. perinei, passes forward in the trigonum urogenitale (see also Figs. 711 and 726), lateral from the a. penis (clitoridis) between the lig. transversum pelvis and the lig. arcuatum pubis and near the lig. suspensiorum penis, to the back of the penis (clitoris); on its way it sends fine branches to the mm. transversus perinei profundus (S_3) and sphincter urethrae membranaceae (S_3) and anastomoses with the nn. cavernosi penis (see p. 793). Upon the penis its lateral, superficial branches go to the corpus cavernosum penis and to the skin of the lateral and inferior surfaces, anastomosing with terminal branches of the n. perinei; its medial, deep branches run lateral from the a. dorsalis penis as far as the glans. Upon the clitoris the nerve is very delicate; it supplies the skin of the clitoris and gives off twigs to the small and large lips.

Plexus coccygeus (see Figs. 870 and 876) is formed chiefly by the anterior branches of the n. sacralis V and the n. coccygeus (see p. 766), but receives also branches from the nn. sacrales III and IV. It lies in front of the origin of the m. coccygeus from the sacrum and coccyx, unites with the lower end of the truncus sympathicus and sends fibres to the viscera. Besides it gives off branches to the mm. sacrococcygei (S_4, S_5) as well as the *nn. anococcygei* (see also Figs. 887 and 888), three to five, which run near the inferior end of the sacrum and near the coccyx through or below the m. coccygeus, backward to the skin over the coccyx and in its neighborhood.

Systema nervorum sympathicum *(sympathetic nervous system, sympathicus)* is formed 1. by a chain of ganglia *(ganglia trunci sympathici)* lying on each side along the spinal column, the ganglia being united with one another by vertical bundles of nerve fibres to form a longitudinal cord, *truncus sympathicus*, 2. by the rami communicantes of the nn. spinales (see p. 736) and communicating rami of the nn. cerebrales, which bring fibres of the spinal and cerebral nerves to the sympathetic ganglia and its branches and also reversely bring sympathetic fibres to the branches of the former, and 3. through peripheral branches, which carry the fibres arising from the cells of the ganglia of the truncus sympathicus, usually accompanying the arteries, to all the organs of the body and which in so doing are characterized by numerous plexus-like communications of their branches wich one another and with those of the cerebral and spinal nerves. In these plexuses, *plexus sympathici*, smaller and larger groups of ganglion cells, *ganglia plexuum sympathicorum (peripheral sympathetic ganglia)*, are frequently intercalated. The branches supply the smooth musculature, the heart musculature, the gland cells and the pigment cells, probably also the cross-striped musculature (tonus) and perhaps the capillaries; they contain also sensory fibres, which, however, pass by the sympathetic ganglion cells.

The sympathicus is divisible into a *head and neck portion, pars cephalica et cervicalis*, a *thoracic portion, pars thoracalis*, and an *abdominal and pelvic portion, pars abdominalis et pelvina;* these are, however, only indistinctly separable from one another.

The ***truncus sympathicus*** (see Figs. 837—839, 871, 876, 890 and 892) extends from the foramen caroticum externum to the coccyx; it sends a continuation (see Figs. 824 and 831) upward into the canalis caroticus, to unite with the ganglia lying upon the branches of the n. trigeminus, and with these to form the head part of the sympathetic trunk. The ganglia of the sympathetic trunk are in general arranged segmentally in the thoracic, abdominal and pelvic portions, that is to say, there is a ganglion corresponding to each spinal nerve, though neighboring ganglia may be united with one another; in the cervical portion they are fused with one another to form two or three ganglia. They are of oblong, rounded or angular form and according to the region of the body in which they are situated are designated as *ganglia cervicalia, thoracalia, lumbalia, sacralia, coccygeum.*

The *rami communicantes of the nn. spinales* (see Figs. 752, 839, 871, 876, 890 and 892) are single or double, sometimes triple and arise usually from the corresponding n. spinalis, sometimes also by single threads from its anterior and posterior roots. Equivalent to these may be regarded the communicating rami of the cerebral nerves, namely of the V., IX., X. and XII. with the sympathicus.

A. ***Pars cephalica et cervicalis systematis sympathici.*** It begins as the *n. caroticus internus* (see Figs. 831 and 837), which proceeds from the upper end of the ganglion cervicale superius (see p. 788), in a way as a continuation of the truncus sympathicus; it lies upon the posterior surface of the a. carotis interna, and by continued subdivision and anastomoses forms a wide-meshed plexus, *plexus caroticus internus* (see also Fig. 824), which accompanies the artery as far as its division and in the sinus cavernosus becomes most close meshed as the *plexus cavernosus.* Delicate plexuses go off from it upon the branches of the a. carotis interna as the *plexus ophthalmicus* (around the a. ophthalmica), *plexus arteriae cerebri anterioris, arteriae cerebri mediae* and *arteriae chorioideae*, and most delicate threads pass to the lobus anterior of the hypophysis cerebri. By means of the *radices sympathicae ganglii ciliaris* (see p. 714 and Figs. 822 and 823), which go from the plexus cavernosus through the fissura orbitalis superior to the ganglion ciliare, it is continued as far as this, and through the *n. petrosus profundus major* (see p. 718 and Fig. 824) it is connected with the ganglion sphenopalatinum. These two ganglia, like the ganglion oticum (see p. 723 and below), which in their structure resemble other sympathetic ganglia, are accordingly to be looked upon as the uppermost head ganglia of the sympathicus. In addition the plexus cavernosus or caroticus internus communicates by fine threads with the nn. oculomotor' (see p. 711), trochlearis (see p. 712), ophthalmicus (V) (see p. 714), abducens (see p. 724), as well as by nn. caroticotympanici (see p. 730) with the n. tympanicus (IX).

In the neck the trunk contains only two or three ganglia (see p. 787). The *ganglion cervicale superius* (see Figs. 835, 837 and 838) is a swelling of the trunk, usually spindle-shaped, approximately 2 cm long, and 5—8 mm broad; it lies in front of the transverse processes of the 2nd—4th cervical vertebra on the fascia praevertebralis and the m. longus capitis, and in front and medialward adjoins the a. carotis interna, in front and lateralward the n. vagus. From its lower end the sympathetic trunk (see Fig. 838) passes in front of the fascia praevertebralis and the mm. longi capitis and colli, behind the a. carotis communis, behind and somewhat medial from the n. vagus downward and presents at about the 6th cervical vertebra on the anterior or posterior surface of the a. thyreoidea inferior the very variable (often absent) small *ganglion cervicale medium* (see Figs. 838, 839 and 890). From the lower end of this ganglion go off usually two (or more) fibres, of which one, the shorter and larger descends behind the a. subclavia, while the other passes around the artery from in front and below like a loop *(ansa subclavia [Vieussenii]*; these go down into the *ganglion cervicale inferius* (see Figs. 838, 840 and 890), a flattened irregular mass situated in front of the transverse process of the 7th cervical vertebra and in front of the neck of the first rib behind the a. subclavia and the origin of the a. vertebralis; it is often wholly or partly fused with the uppermost ganlion thoracale. The ganglion submaxillare (see p. 723 and below) also belongs to the cervical part of the sympathetic system.

The ganglion cervicale superius is united by the delicate *n. jugularis* (see Fig. 837), which passes upward from the upper end close by the n. caroticus internus and bifurcates with the ganglion petrosum n. glossopharyngei and ganglion jugulare n. vagi, also by fine threads with the ganglion nodosum n. vagi and with the n. hypoglossus, as well as by rami communicantes with the 1st—4th (or 3rd) cervical nerve (see Fig. 835). The ganglion cervicale medium (or when this is absent, the corresponding part of the trunk) is united by rami communicantes usually with the (4th) 5th, 6th (and 7th) cervical nerve, the ganglion cervicale inferius with the (7th) 8th cervical and 1st thoracic nerve (see Fig. 890).

The following are designated as peripheral branches:

1. From the ganglion cervicale superius:

a) Vascular branches (as a rule, not illustrated): They arise usually as two fine threads, *nn. carotici externi* (not illustrated), which run to the a. carotis externa and downward on it as far as its origin; they form a plexus, *plexus caroticus externus,* around this artery, from which plexus-like twigs are given off to the branches of the artery, namely: *plexus thyreoideus superior, lingualis, maxillaris externus* (from which the *radix sympathica gangli submaxillaris* for the ganglion submaxillare [see p. 723 and above], similar in structure to other sympathetic ganglia is derived), *plexus occipitalis, auricularis posterior, temporalis superficialis, maxillaris internus, meningeus* (on the a. meningea media, from which go off threads to the ganglion oticum [see p. 723 and above], which belongs to the sympathicus, and *plexus pharyngeus ascendens* on arteries of corresponding name; the main plexus is continued as the *plexus caroticus communis* upon the a. carotis communis.

b) Visceral branches: *Rami laryngopharyngei* (see Fig. 838) go off independently or from one of the branches, pass partly to the n. laryngeus superior and with this to the larynx, partly to the lateral wall of the pharynx, there to form the plexus pharyngeus (see p. 733) with the rami pharyngei of the nn. glossopharyngeus and vagus.

c) *N. cardiacus superior* (see Figs. 838, 839 and 846), larger on the left side, arises simply or by several roots from the lower end of the ganglion or from the trunk, passes medial from the latter behind the a. carotis communis, downward directly in front of the fascia praevertebralis, behind or in front of the a. thyreoidea inferior, on the right side along the a. anonyma, on the left side along the a. carotis communis to reach the arch of the aorta and the plexus cardiacus. In the neck it unites repeatedly with the n. laryngeus superior, the rami cardiaci superiores n. vagi and the n. recurrens (see p. 733) and sends fine threads to the plexus thyreoideus inferior.

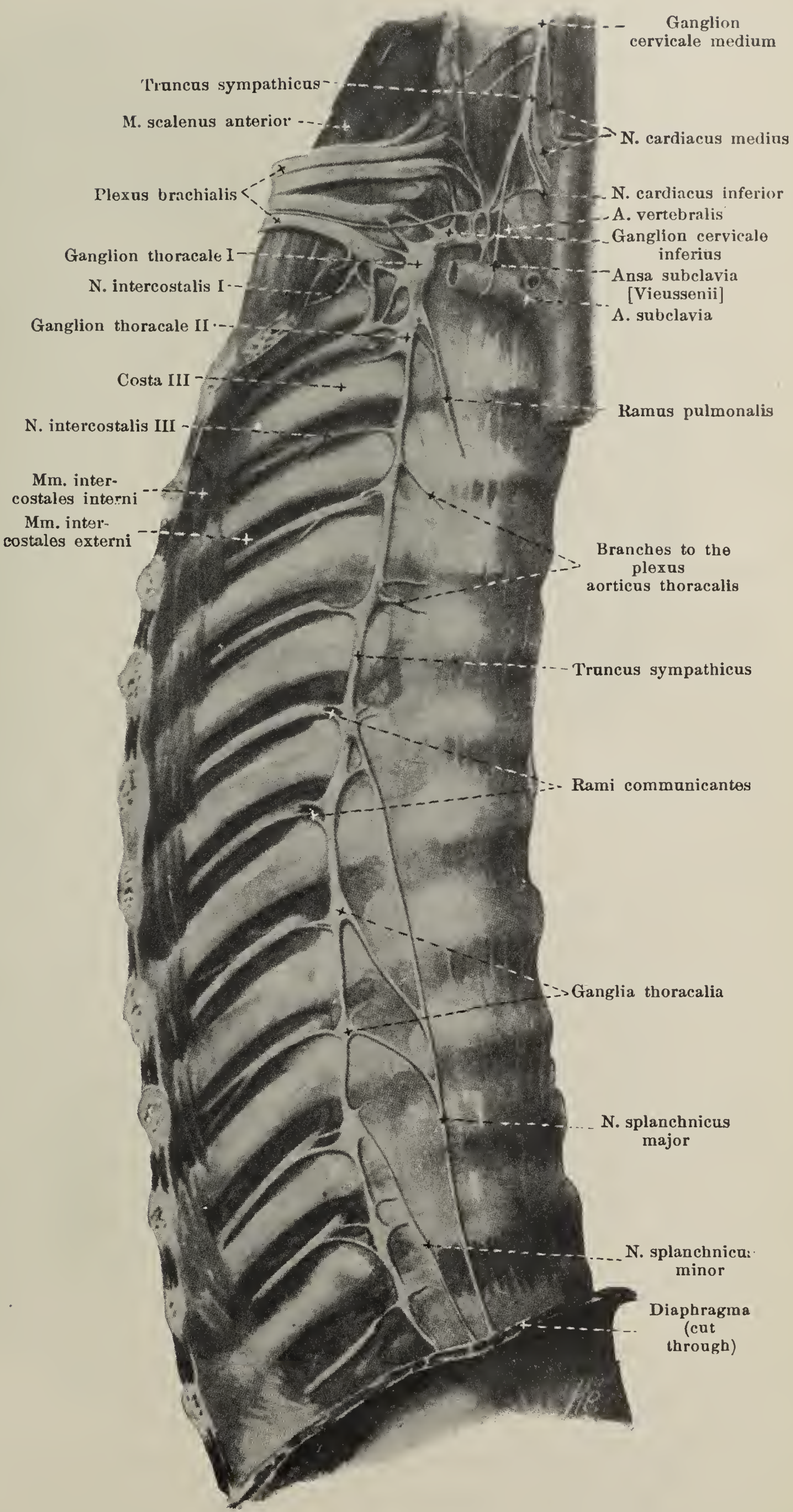
2. From the ganglion cervicale medium or from the front of the trunk corresponding to it:

a) Vascular branches, very fine, partly to the *plexus caroticus communis* (vide supra), partly to the a. thyreoidea inferior, around which they form the *plexus thyreoideus inferior* (not illustrated), together with branches of the ganglion cervicale inferius and of the nn. cardiaci superior and medius.

890. Right sympathetic trunk in the thoracic cavity,

viewed from the right and from in front.

(The pleura and fascia endothoracica have been removed. Of the sympathicus only a few branches are drawn.)

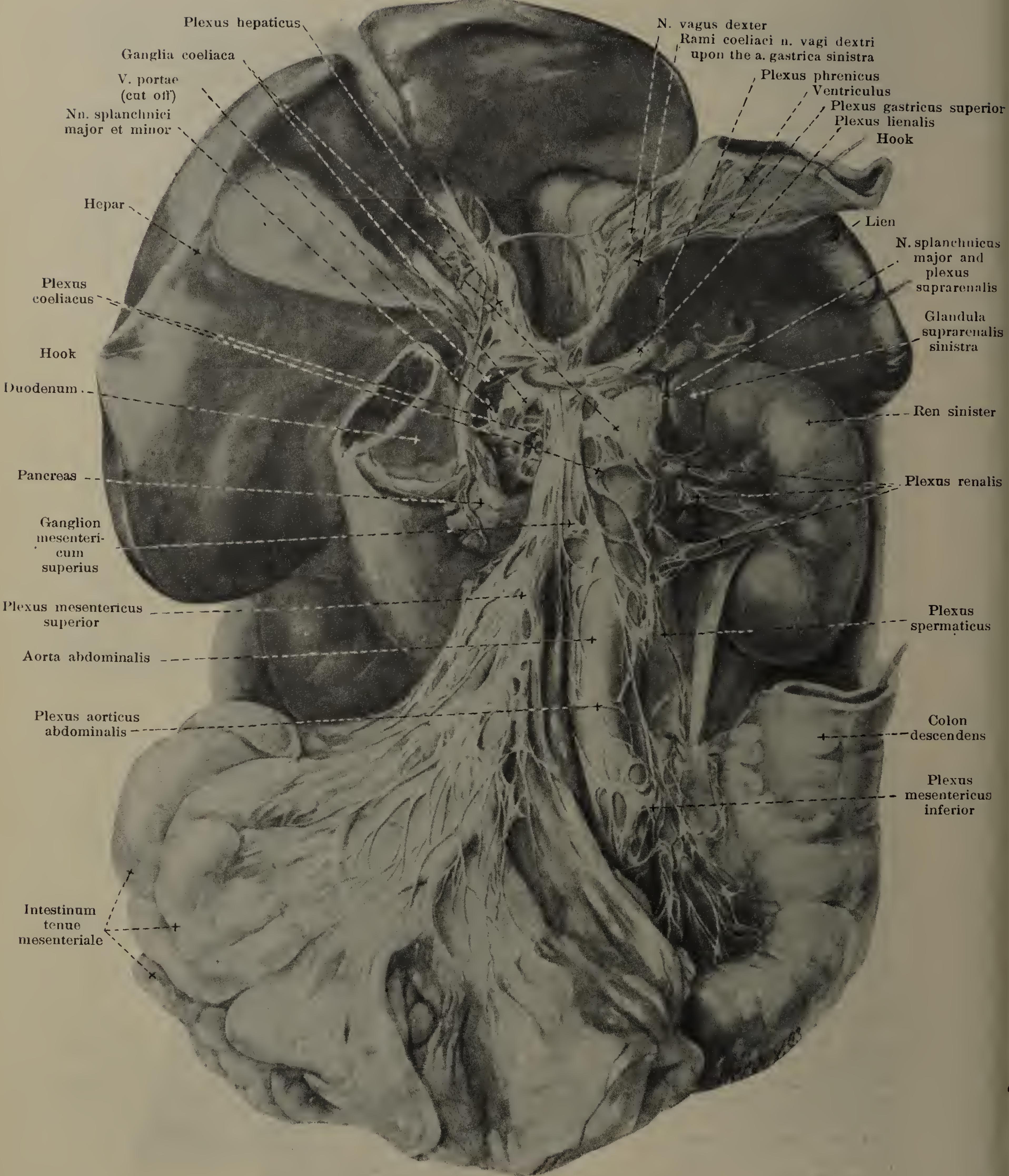


b) *N. cardiacus medius* (see also Figs. 838, 839 and 846), usually larger than the superior, arises simply or by several roots from the ganglion or from the trunk itself and runs behind the a. carotis communis, in front of or behind the a. subclavia, on the right side along the a. anonyma, to the arch of the aorta and the plexus cardiacus. In the neck it forms anastomoses similar to those of the n. cardiacus superior (see p. 788).

3. From the ganglion cervicale inferius:

a) Vascular branches (not shown) to the *plexus thyreoideus inferior* (see p. 788), *plexus subclavius* (around the a. subclavia) and *plexus mammarius internus* (around the a. mammaria interna), but especially to the *plexus vertebralis*, surrounding the a. vertebralis, a plexus which during its course to the brain communicates by fine threads with the cervical nerves.

b) *N. cardiacus inferior* (see also Fig. 839) goes off usually by several roots from the lowermost cervical and the uppermost thoracic ganglion, passes on the right side behind the a. anonyma, on the left side in front of or behind the a. subclavia to the arcus aortae and plexus cardiacus.


Plexus hepaticus
Ganglia coeliaca
V. portae (cut off)
Nn. splanchnici major et minor
Hepar
Plexus coeliacus
Hook
Duodenum
Pancreas
Ganglion mesentericum superius
Plexus mesentericus superior
Aorta abdominalis
Plexus aorticus abdominalis
Intestinum tenue mesenteriale
N. vagus dexter
Rami coeliaci n. vagi dextri upon the a. gastrica sinistra
Plexus phrenicus
Ventriculus
Plexus gastricus superior
Plexus lienalis
Hook
Lien
N. splanchnicus major and plexus suprarenalis
Glandula suprarenalis sinistra
Ren sinister
Plexus renalis
Plexus spermaticus
Colon descendens
Plexus mesentericus inferior

891. Abdominal plexuses of the sympathicus, viewed from in front. (Stomach and large intestine have been for the most part removed; the pars ascendens duodeni has been excised. The liver is displaced upward, the stomach and the spleen to the left, the small intestine downward. The peritonaeum has been partly dissected off.)

Plexus cardiacus, heart plexus (see Figs. 839 and 846), is formed by the plexus-like anastomoses around the arch of the aorta of the rami cardiaci n. vagi and the nn. cardiaci of the sympathicus of both sides as well as by branches of the 1st to the 5th ganglion thoracale. In it there can be distinguished a feebler, superficial portion, spread out on the left, anterior part of the aortic arch, between it and the site of bifurcation of the a. pulmonalis, and formed chiefly by the rami cardiaci of the left n. vagus and by the left n. cardiacus superior, and frequently possessing the *ganglion cardiacum [Wrisbergi]* (not illustrated), as well as a larger, deeper portion; the latter lies on the right, posterior surface of the aortic arch, between it and the bifurcation of the trachea, and is formed by all the other heart-nerves. The heart plexus sends direct branches to the atria, as well as the *plexus coronarius cordis anterior* on the a. coronaria [cordis] dextra and the *plexus coronarius cordis posterior* on the a. coronaria sinistra, besides others to the plexus pulmonales of the nn. vagi (see p. 734).

C. ***Pars thoracalis s. sympathici*** (see Figs. 680—682, 839 and 890). The sympathetic trunk extends caudalward in front of the heads of the ribs and in front of the aa. and vv. intercostales, covered directly by the pleura and contains 10—12 *ganglia thoracalia,* situated in front of the heads of the ribs or in front of the intercostal vessels or nerves; below it turns somewhat ventralward and passes between the crus intermedium and crus laterale of the diaphragm into the abdominal cavity. Each ganglion is united by one or several rami communicantes with the adjacent n. intercostalis. The ganglia give off besides numerous branches to the n. vagus:

a) Vascular branches to the arcus aortae (see above) and to the aorta thoracalis; these together with outrunners from the plexus cardiacus form the *plexus aorticus thoracalis*, which is connected below with the plexus coeliacus.

b) *Rami pulmonales* (from the 1st to the 6th ganglion thoracale) to the plexus pulmonales (see p. 734), as well as branches to the plexus oesophagei (see p. 734).

c) *N. splanchnicus major* arises with several roots from the 5th or 6th to the 9th thoracic ganglion, is of a white color like the spinal nerves; its fibres arise chiefly from the spinal cord and go past the sympathetic ganglion cells. It runs distialward and somewhat medianward upon the bodies of the thoracic vertebrae and possesses in front of the 12th thoracic vertebra, regularly on the right side, and frequently on the left side, a small *ganglion splanchnicum* (not designated); it passes between the crus mediale and the crus intermedium of the diaphragma into the abdominal cavity and enters the corresponding ganglion coeliacum (see Fig. 891).

d) *N. splanchnicus minor,* of the same appearance and structure as the foregoing, arises from the 10th—12th thoracic ganglion, extends close to the foregoing nerve, sometimes united with it, downward through the diaphragm, enters the ganglion coeliacum near the a. renalis and sends a *ramus renalis* (not designated) to the plexus renalis.

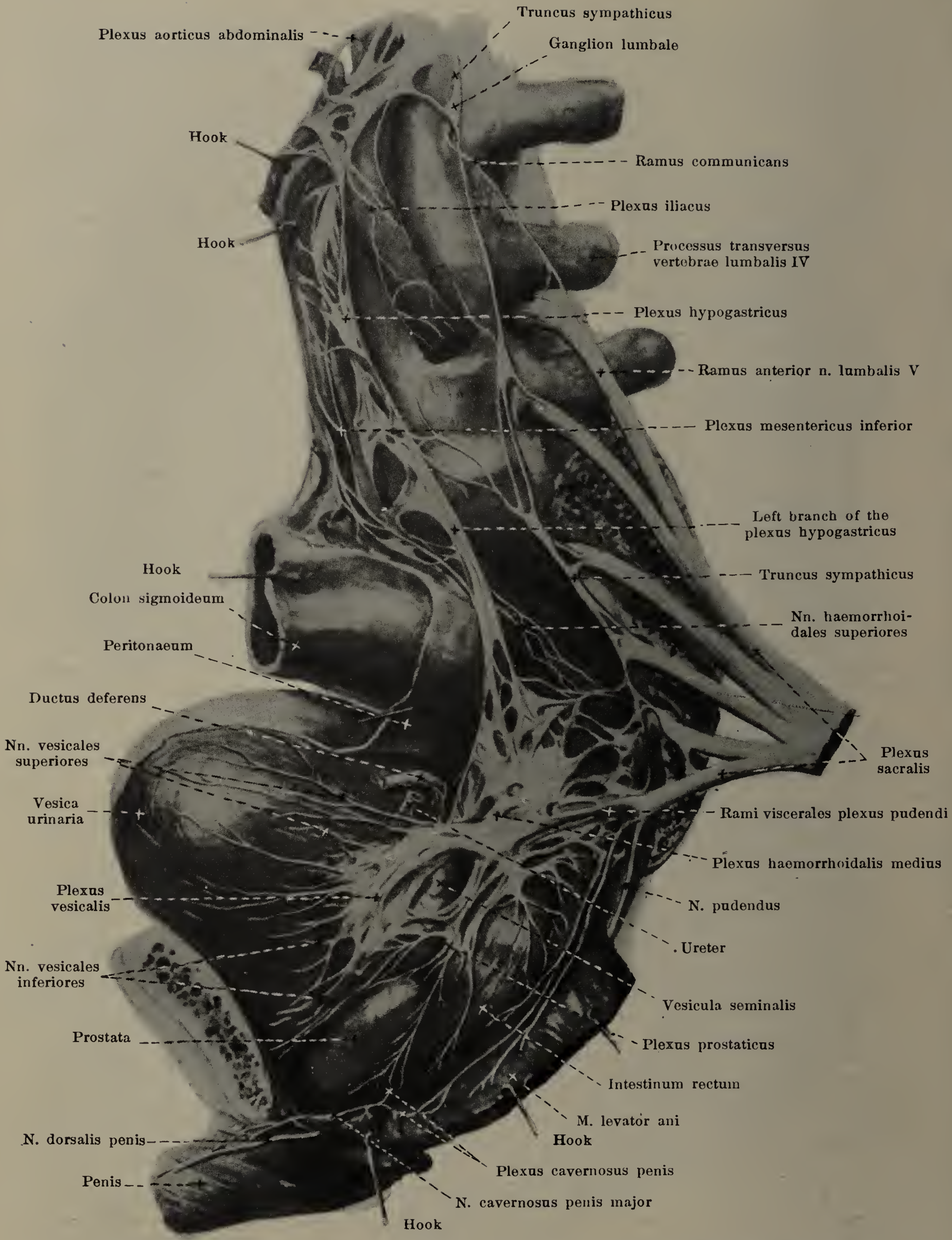
D. ***Pars abdominalis s. sympathici*** (see Figs. 871, 876 and 891). The sympathetic trunk runs directly upon the bodies of the lumbar vertebrae, ventral and medianward from the origins of the m. psoas major, on the right side behind the v. cava inferior, on the left behind the aorta abdominalis downward and near the promontorium curves upon the facies pelvina oss. sacri; it contains 5 (or 4) small *ganglia lumbalia.* Its rami communicantes are usually double and run near the aa. lumbales between the bodies of the vertebrae and the tendon arches of the m. psoas.

Its main plexus is the unpaired *plexus coeliacus,* which lies behind the pancreas and the bursa omentalis directly upon the anterior surface of the aorta abdominalis and the crura diaphragmatis, surrounds the origins of the aa. coeliaca and mesenterica superior, lateralward as far as the suprarenals reaches downward as far as the origin of the aa. renales, and is continuous upward through the hiatus aorticus with the plexus aorticus thoracalis. It is formed by the nn. splanchnici major and minor of both sides, by the rami coeliaci of the right n. vagus, and by threads from the upper lumbar ganglia of the sympathicus. Intercalated in this plexus on each side there is constantly a large, flat, very variable *ganglion coeliacum,* which may be subdivided into several small ones, and often a small *ganglion mesentericum superius* is found beneath the root of the a. mesenterica superior.

The following branch-plexuses go off from the plexus coeliacus chiefly with the arteries:

Paired plexuses:

Plexus phrenicus with the a. phrenica inferior, which unites with the rami phrenicoabdominales n. phrenici (see p. 743) and on the right side possesses a small *ganglion phrenicum* (not illustrated); *plexus suprarenalis,* numerous fine threads to the dorsal surface of the suprarenal; *plexus renalis* with threads from the lumbar ganglia around the a. renalis to the kidney, receiving the ramus renalis of the n. splanchnicus minor; *plexus spermaticus* around the a. spermatica interna in the male to the testicle, in the female *(plexus arteriae ovaricae)* to the ovarium and fundus uteri, where it anastomoses with the plexus uterovaginalis.



892. Pelvic plexuses of the sympathicus,

viewed from the left.

(The left half of the pelvis with its muscles has been in large part removed; the plexus sacralis and the m. levator ani have been drawn somewhat aside.)

Unpaired plexuses (see Fig. 891.):

Plexus lienalis with the a. lienalis to the spleen, to the pancreas and fundus ventriculi; *plexus hepaticus* near the a. hepatica and the ductus choledochus to the liver (anastomosing with rami hepatici n. vagi sinistri) and gall bladder, to the pylorus and along with the branches of the a. gastroduodenalis to the pancreas, duodenum and to the curvatura major ventriculi (*plexus gastricus inferior*, not designated); *plexus gastricus superior* along with the a. gastrica sinistra to the curvatura minor ventriculi, where it unites with branches of the nn. vagi; *plexus mesentericus superior*, the largest, accompanies the a. mesenterica superior and its branches to the pancreas, duodenum, small intestines, caecum, colon ascendens and the larger part of the colon transversum and forms within the wall of the small intestine, between the longitudinal and circular walls of muscle, the narrower-meshed *plexus myentericus*, in the tela submucosa the wider-meshed *plexus submucosus* (not illustrated).

Plexus aorticus abdominalis (see Figs. 891 and 892) consists essentially of two lateral cords uniting by transverse threads which are developed from the plexus coeliacus and receive threads from the lumbar ganglia. Around the a. mesenterica inferior it is continued as the *plexus mesentericus inferior* and thus arrives at the colon transversum, descendens and sigmoideum, and as the *mm. haemorrhoidales superiores* to the upper part of the rectum, where it anastomoses with the plexus haemorrhoidalis medius; in the wall of the intestine it behaves like the plexus mesentericus superior.

The plexus aorticus is continuous below with the *plexus hypogastricus* (see Fig. 892), which at first runs as an unpaired, flat, broad plexus, as far as the promontorium, there bifurcates and then extends on each side on the medial side of the a. hypogastrica, dorsal and lateral from the rectum, as far as the large pelvic plexus (vide infra); it receives branches from the lumbar and sacral ganglia.

Another continuation of the plexus aorticus is met with in the feebler *plexus iliacus* upon the a. iliaca communis; it again goes over into the delicate *plexus femoralis* upon the a. femoralis and *plexus popliteus* upon the a. poplitea.

E. ***Pars pelvina s. sympathici*** (see Figs. 871, 876 and 892). The sympathetic trunk lies directly upon the facies pelvina of the sacrum, medial from the foramina sacralia anteriora, dorsal and lateral from the rectum, and usually presents there four *ganglia sacralia;* the right and left trunk converge somewhat caudalward, so that on the anterior surface of the 1st coccygeal vertebra they either unite by a simple loop, or both end there (more rarely) in a small unpaired *ganglion coccygeum.* Each ganglion is united by one or two rami communicantes with the corresponding nerves.

On the lateral surface of the pelvic viscera, between them and the medial upper surface of the diaphragm pelvis is the large pelvic plexus (see Fig. 892), which is only indistinctly separable into the single portions belonging to individual viscera. It is formed by the lower ends of the plexus hypogastrici, by branches of the pelvic ganglia, as well as by the rami viscerales of the plexus pudendus (nn. haemorrhoidales medii, nn. vesicales inferiores and nn. vaginales) (see p. 786). Of the subdivisions of this large plexus the following are common to both sexes:

a) *Plexus haemorrhoidalis medius*, farthest dorsalward, on the lateral surface of the rectum, around the a. haemorrhoidalis media, receives the nn. haemorrhoidales superiores and sends branches to the wall of the rectum.

b) *Plexus vesicalis*, situated farthest ventralward, on the lateral surface of the bladder; it sends *nn. vesicales superiores* to the upper, *nn. vesicales inferiores* to the lower part of the bladder; the former give off branches to the ureter, the latter to the urethra.

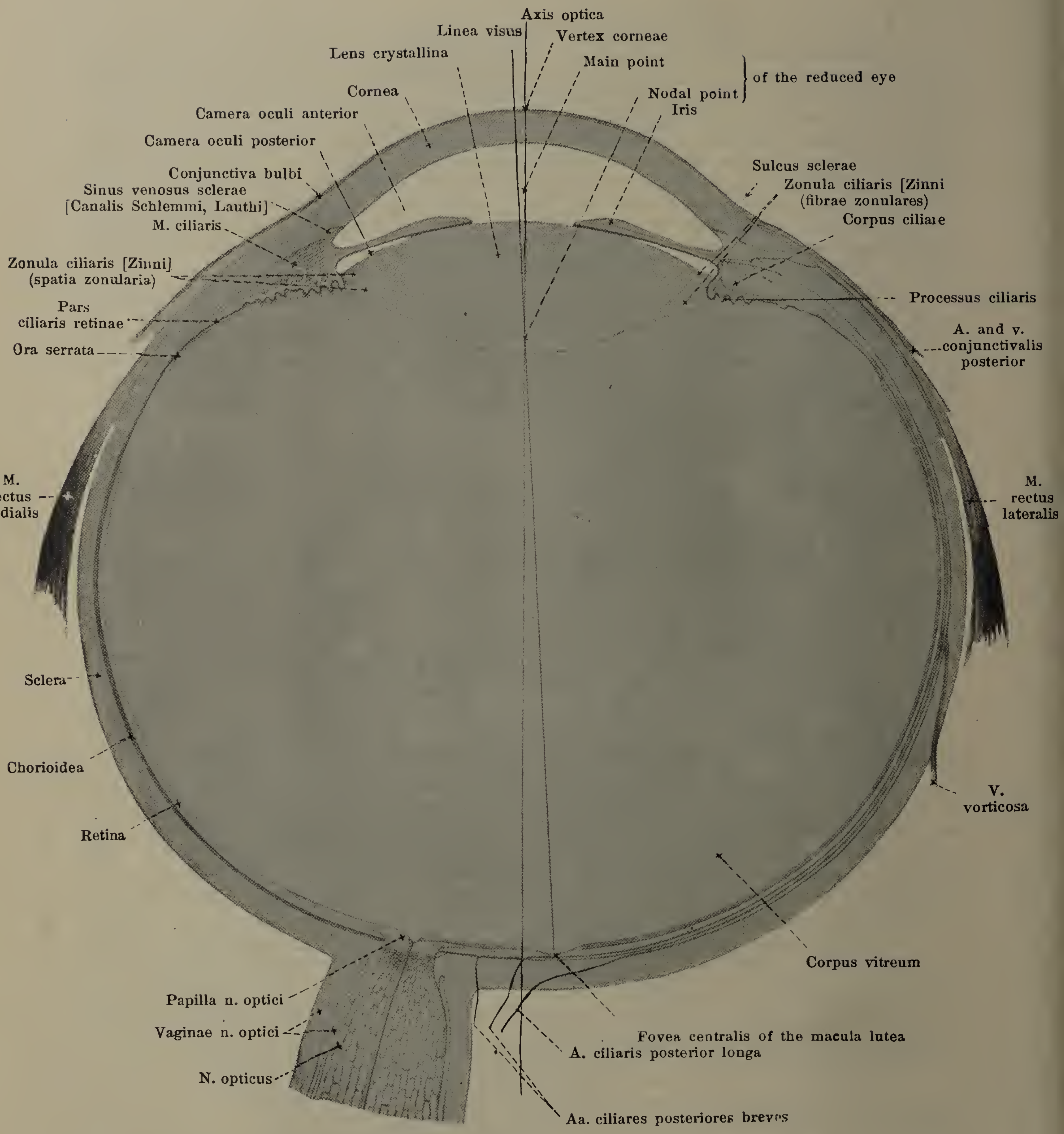
The following are present in the male only:

c) *Plexus deferentialis* (not designated) about the seminal vesicle and ductus deferens, with branches to these.

d) *Plexus prostaticus*, lateral from and behind the prostata, which branches to it.

c) *Plexus cavernosus*, a continuation of the preceding; it passes lateral and dorsal from the prostata to the trigonum urogenitale, and through this upon the back of the penis, where it anastomoses with branches of the n. dorsalis penis. It gives off branches to the pars membranacea of the urethra, and ends in the *nn. cavernosi penis major et minores*, which penetrate the corpora cavernosa penis

In the female: f) *Plexus uterovaginalis* (not illustrated) in the parametrium on the lateral surface of the cervix uteri and of the upper part of the vagina, sends branches with the a. uterina to the uterus (anastomoses with the plexus arteriae ovaricae), as well as to the vagina. From the anterior surface of the vagina a fine *plexus cavernosus clitoridis* with *nn. cavernosi clitoridis major et minores* goes to the clitoris.



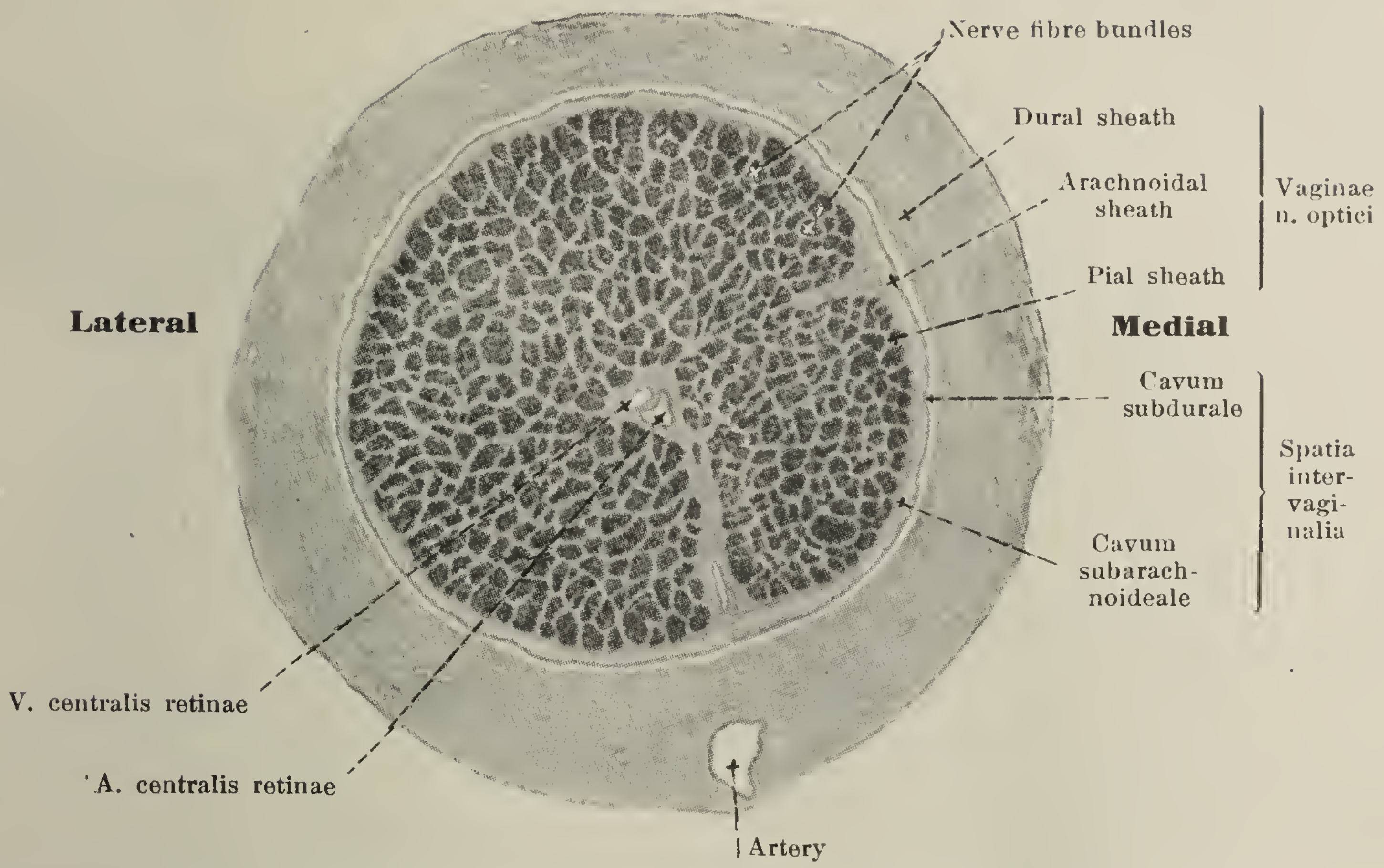
893. Schematic section through the right eye in the horizontal meridian, viewed from above (after H. Sattler).

Magnification: 5:1.

The **organon visus** *(organ of vision)* consists of the *eye (oculus)* and of the *appendages of the eye (organa oculi accessoria).*

The *eye* consists of the *n. opticus (optic nerve)* and the *bulbus oculi (eyeball).*

The *accessory organs of the eye* include the *musculi oculi (eye muscles), fasciae orbitales (fascia of the orbital cavity), palpebrae (eyelids), conjunctiva* and the *apparatus lacrimalis (tear apparatus).*



894. Cross-section of the optic nerve a little in front of the entrance of the a. centralis retinae. (After a preparation by H. Sattler.) Magnification: 15:1.

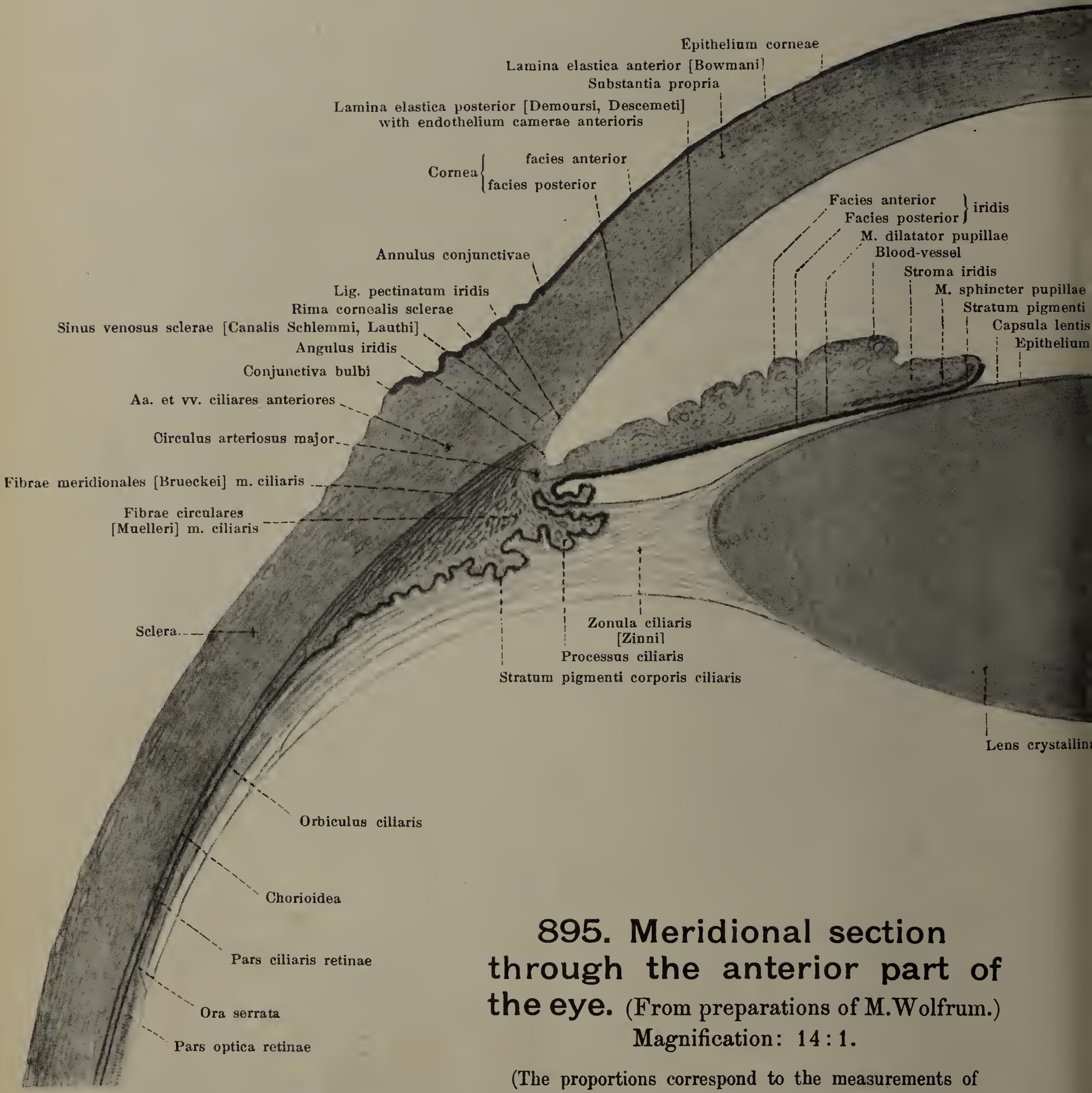
(The bundles of nerve fibres are dark in the drawing.)

The **n. opticus** *(optic nerve)* (see also p. 711 and Figs. 893, 904, 905 and 919—924) is variably curved in the orbital cavity; in the vertical direction it is curved so as to be slightly bayonet-shaped, in the horizontal direction slightly S-shaped, behind lateralward, in front medianward convex, and enters into the posterior surface of the eyeball about 3 mm medial from, and somewhat below, the posterior end of the optic axis. It is enclosed in its *sheaths, vaginae n. optici* (see also Figs. 893, 904 and 905), which are continuations of the brain-membranes, and at the eyeball go over into the sclera. The outer thickest *dural sheath* consisting of tough connective tissue, is derived from the dura mater and forms the periosteum lining the foramen opticum. Following upon this is the delicate *arachnoidal sheath*, a continuation of the arachnoidea, and upon this a continuation of the pia mater, the *pial sheath*, which is connected by fine strands with the arachnoidal sheath and sends septa in between the bundles of nerve fibres. The sheaths are separated from one another by the *spatia intervaginalia*, and between the dural and arachnoidal sheaths is a continuation of the cavum subdurale, between the arachnoidal and pial sheaths a continuation of the cavum subarachnoideale; both of these extend forward as far as the sclera but do not communicate with one another there.

The a. and v. centralis retinae enter the optic nerve about 1 cm behind the eyeball, constantly entering in the medial part of its inferior circumference; they then run farther forward in the axis of the nerve.

The fibres of the n. opticus are medullated, but lose their myelin-sheaths immediately behind the lamina cribrosa sclerae (see p. 797 and Fig. 904); the nerve accordingly narrows on passage through the coats of the bulbus.

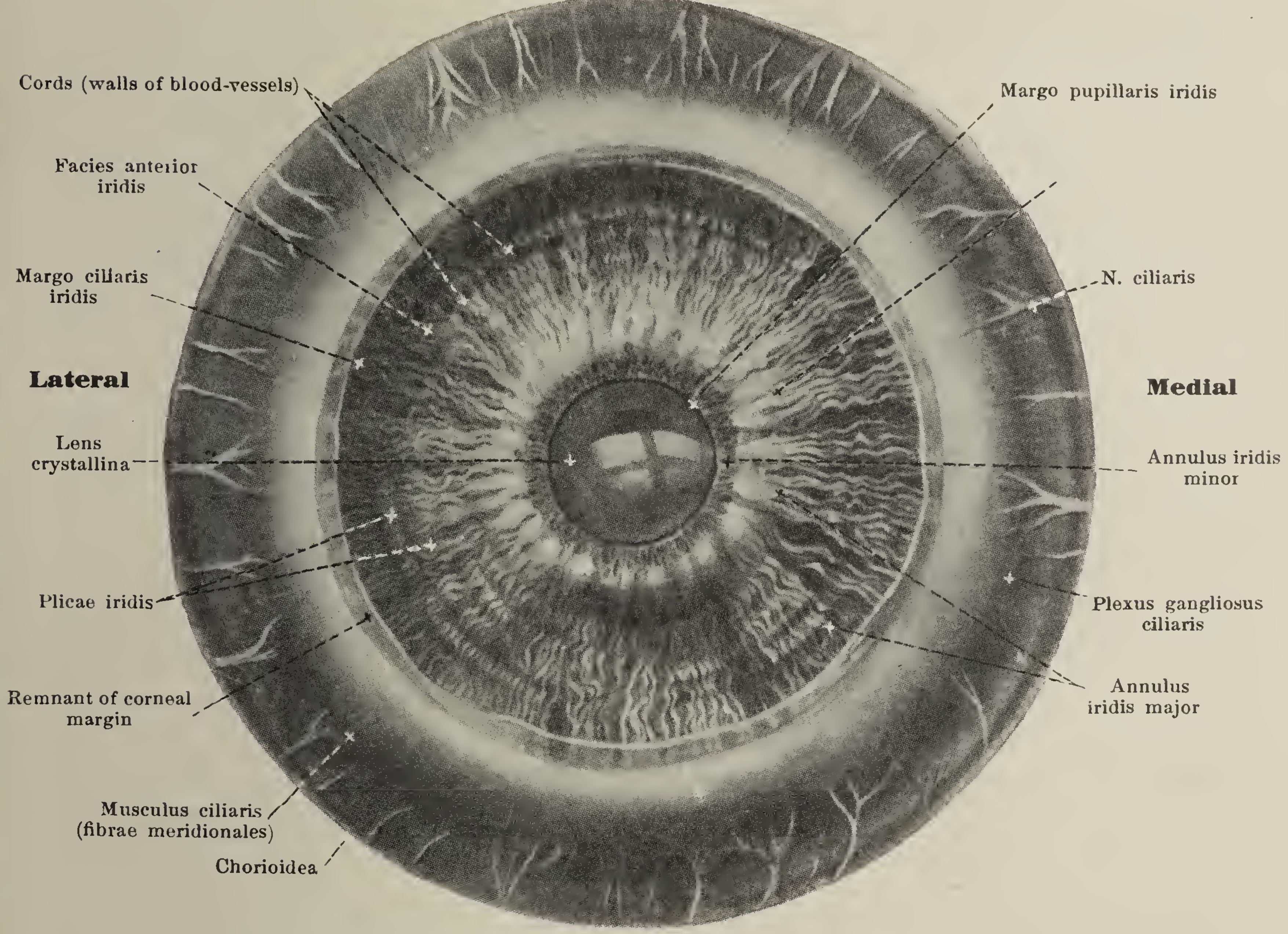
The **bulbus oculi** *(eyeball)* (see Figs. 893 and 900) lies, surrounded by fat, fasciae and muscles, in the orbital cavity and presents, roughly speaking, the form of a sphere. In describing it, therefore, expressions corresponding to those used for the globe are employed, thus an *anterior pole, polus anterior*, in the vertex corneae is spoken of, and a *posterior pole, polus posterior*, in the middle point of the posterior convexity, somewhat medianward and a little above from the spot in the sclera corresponding to the fovea centralis. The line uniting the two poles is called the *axis oculi externa*, the distance measured upon it, between the posterior surface of the cornea, and the anterior surface of the retina, being called the *axis oculi interna;* it coincides with the *optic axis*, *axis optica*, which contains the centres of the different refracting surfaces of the eye. The largest circle, the plane of which stands perpendicular to the optic axis, is called the *aequator;* circles which go through both poles are called *meridiani;* by the vertical and the horizontal meridian the bulbus is divided into four quadrants. The name *visual line, linea visus*, is given to the line which in the reduced eye is drawn from an external object through the nodal point to the fovea centralis.



895. Meridional section through the anterior part of the eye. (From preparations of M. Wolfrum.) Magnification: 14 : 1.

(The proportions correspond to the measurements of H. von Helmholtz.)

The **bulbus oculi** resembles a section of a sphere fairly complete only in its posterior half. The anterior half possesses a frontal, shallow, circular indentation, ***sulcus sclerae*** (see Fig. 893), from which the most anterior part projects as a small segment of a sphere (see p. 798) with smaller radius of curvature. This projection belongs to the cornea, the other part of the surface to the sclera, so that the sulcus sclerae indicates at the same time the external junction between the cornea and the sclera.



896. Iris of a grayish-blue right eye, along with corpus ciliare and chorioidea, viewed from in front.

Magnification: 6 : 1. (The cornea and sclera have been removed.)

The **bulbus oculi** (see Fig. 893) is formed of the *contents (nucleus) of the eyeball,* in the interior, and of the *coats of the eye* ensheathing these externally. The former, from before backward, consists of 1. the *humor aqueus,* 2. the *lens crystallina, lens,* and 3. the *corpus vitreum, glass body.* The coats of the eye are concentrically laminated and consist, from the outside in, of 1. the *tunica fibrosa oculi,* 2. the *tunica vasculosa oculi,* and 3. the *retina.*

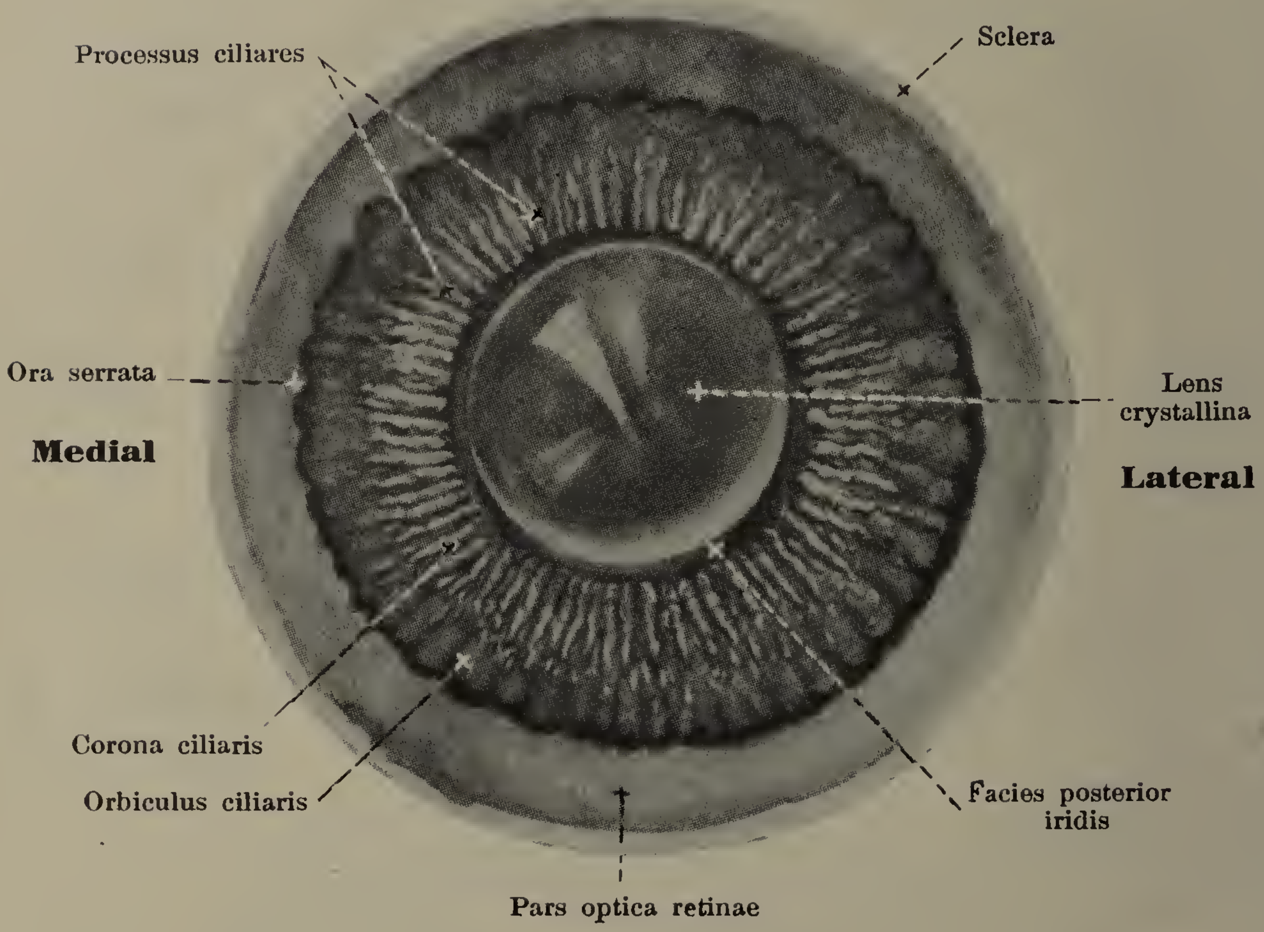
The **tunica fibrosa oculi** (see Figs. 893 and 895) is a tough, thick membrane completely enclosing the eyeball, and conditioning its form. About five-sixths of it consists of the non-transparent *sclera,* one sixth of the transparent *cornea,* which surrounds the anterior pole.

The ***sclera,*** *white* or *hard coat of the eye* (see Figs. 893, 895, 900, 904, 905, 923 and 924), is a tough connective tissue membrane, usually of a pure white color. It is thickest at the entrance of the optic nerve, the sheaths of which go over directly into it, and passing forward it becomes gradually thinner as far as the attachments of the straight eye-muscles, the tendon bundles of which interweave with it and strengthen it in its most anterior part. It is loosely covered in its anterior part by the conjunctiva bulbi, and is thus far also visible in the lid-slit as the white of the eye (see Figs. 927 and 928). In front the non-transparent bundles of the sclera go over directly into the transparent ones of the cornea; this transition occurs, so that the sclera in a way forms a groove, *rima cornealis,* for the reception of the margin of the cornea, *limbus corneae.* Just behind this transition in a furrow of the sclera, runs a circular blood-vessel, *sinus venosus sclerae [canalis Schlemmi, Lauthi]* (see p. 802), which is bounded internally by the lig. pectinatum iridis. The sclera is perforated behind by the n. opticus; bundles of connective tissue arranged in the form of a net-work separate the individual bundles of nerve fibres from one another and form a perforated plate, *lamina cribrosa sclerae,* for the passage of the latter. In addition the sclera possesses openings for the passage of the aa., vv. and nn. ciliares.

897. Anterior part of a right eye, viewed from behind.

Magnification: 3 : 1.

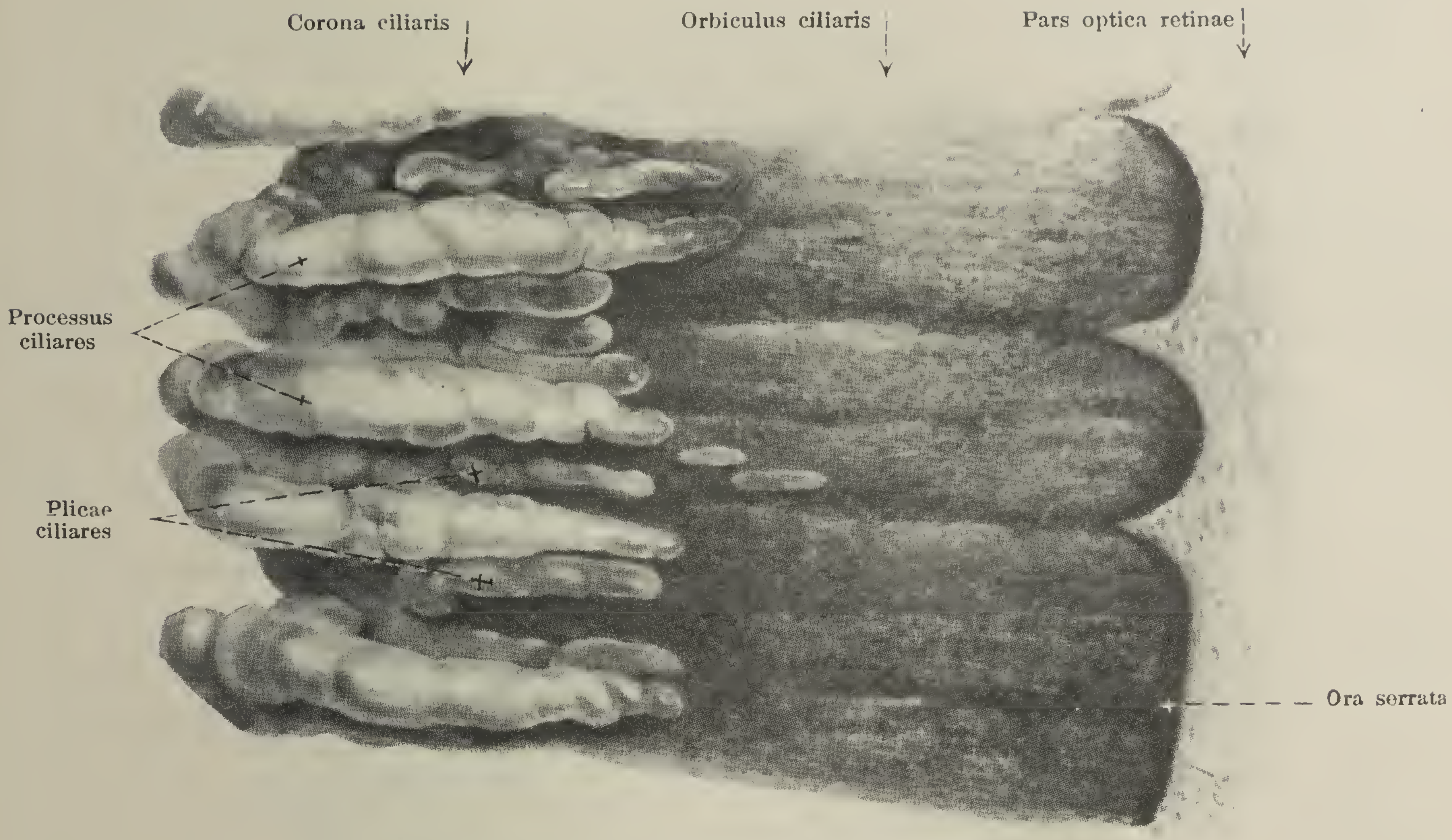
(The zonula ciliaris [Zinni] has not been represented.)



Sclera (continued): On its outer surface it is united by a delicate net-work with the surrounding fascia bulbi [Tenoni] (see p. 816), which, however, does not inhibit the movability of the eyeball. Its innermost layer lies everywhere in direct contact with the tunica vasculosa, is colored brownish by numerous pigment cells, and is accordingly called the *lamina fusca sclerae.*

The ***Cornea*** (see Figs. 893, 895, 924, 927 and 928) is a colorless, transparent and non-vascular connective tissue membrane, and has the shape of a flat, round bowl curved so as to be convex in front, concave behind. At its margin, *limbus corneae* (see p. 797), the sclera above and below reaches somewhat farther forward than medially and laterally; hence the circumference of the cornea viewed from in front looks like an ellipse with its longest diameter placed transversely; viewed from behind it is circular. The anterior surface of the cornea resembles approximately an ellipsoid of rotation only in the zone of the pole: it is thereby a little more markedly curved in the vertical direction than in the transversal. Its thickness is greater than that of the neighboring sclera, but diminishes gradually from the margin on and is least at the point of greatest convexity, the *vertex corneae.* The convex, anterior surface. *facies anterior*, lies free to view in the lid-slit and is covered by the *epithelium corneae,* an indirect continuation of the epithelium of the conjunctiva bulbi, which is attached for the most part loosely on the anterior surface of the sclera and is connected with it firmly only in a narrow, often ridge-like strip, *annulus conjunctivae,* immediately surrounding the cornea, and which then goes over without sharp limit into the anterior layers of the cornea. The epithelium corneae rests upon the narrow, very transparent *lamina elastica anterior [Bowmani],* and this goes over behind into the laminated *substantia propria,* which forms the main mass; then follows the *lamina elastica posterior [Demoursi, Descemeti],* which resembles the anterior but is thinner, and finally the *endothelium camerae anterioris;* this covers the facies posterior of the cornea, forms the anterior boundary of the anterior chamber of the eye filled with aqueous humor, and is continuous lateralward upon the angulus iridis.

The **tunica vasculosa oculi** (see Fig. 893) with its main mass lies directly on the inner surface of the sclera; only its most anterior portion, the *iris,* projects inward free into the bulbus from the region of the rima cornealis, approximately transversely to the optic axis. The part lying against the sclera is divisible into a larger, posterior, smooth portion, the *chorioidea,* and a narrow, anterior, ridged portion, the *corpus ciliare;* it is firmly fused with the sclera behind only at the entrance of the optic nerve and in front at the rima cornealis, but otherwise is separated from it by a slit-like space, *spatium perichorioideale,* transversed by numerous fine, pigmentholding lamellae, which is bounded externally by the lamina fusca sclerae (vide supra) and internally by the most superficial layer of the chorioidea, the *lamina suprachorioidea,* and is perforated by some vessels and nerves. All portions of it are very delicate and contain an extraordinarily large number of blood vessels, numerous nerves and ganglia; the corpus ciliare and the iris contain smooth muscles in addition.

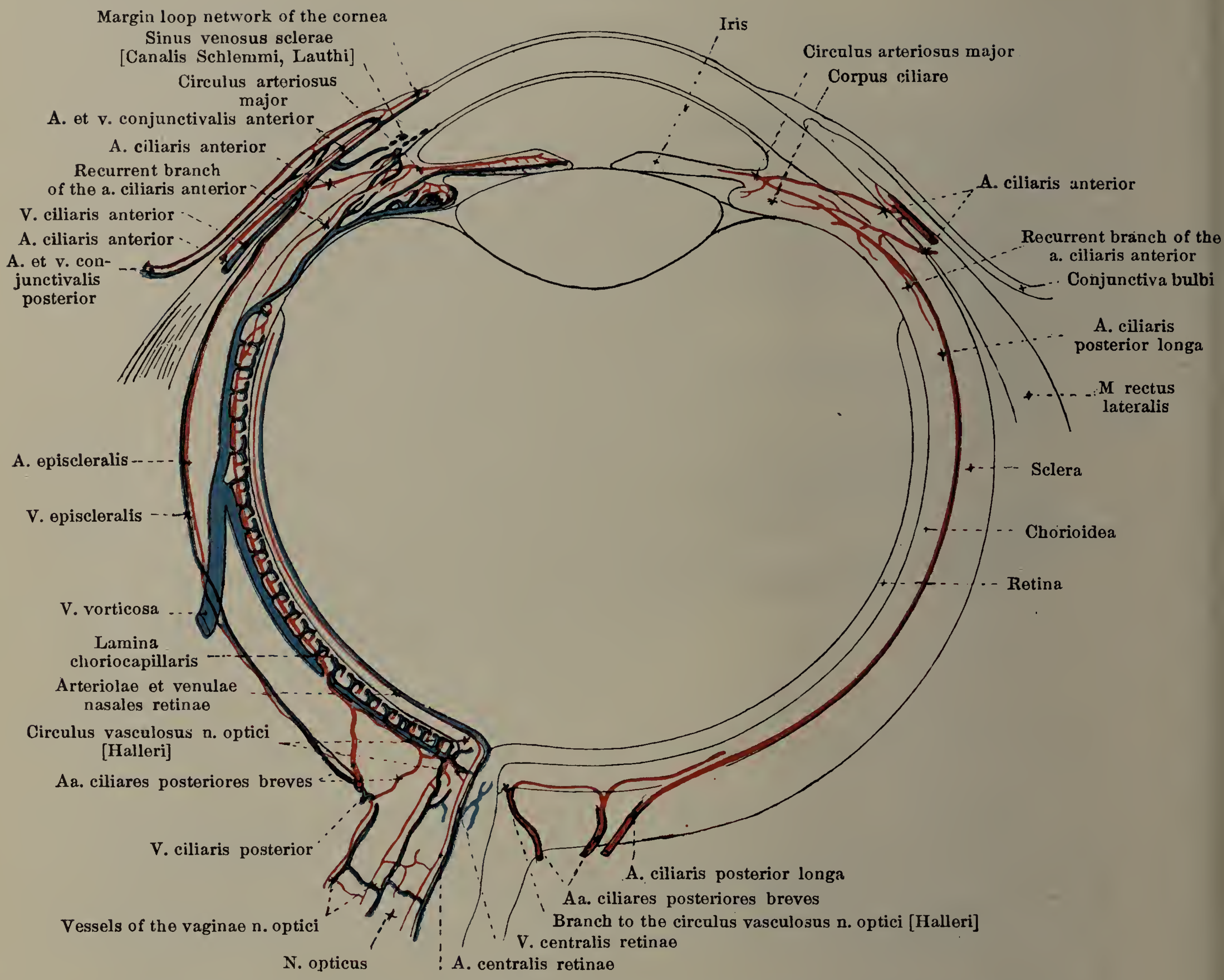


898. Portion of the ciliary body, viewed from behind.

Magnification: 25 : 1.

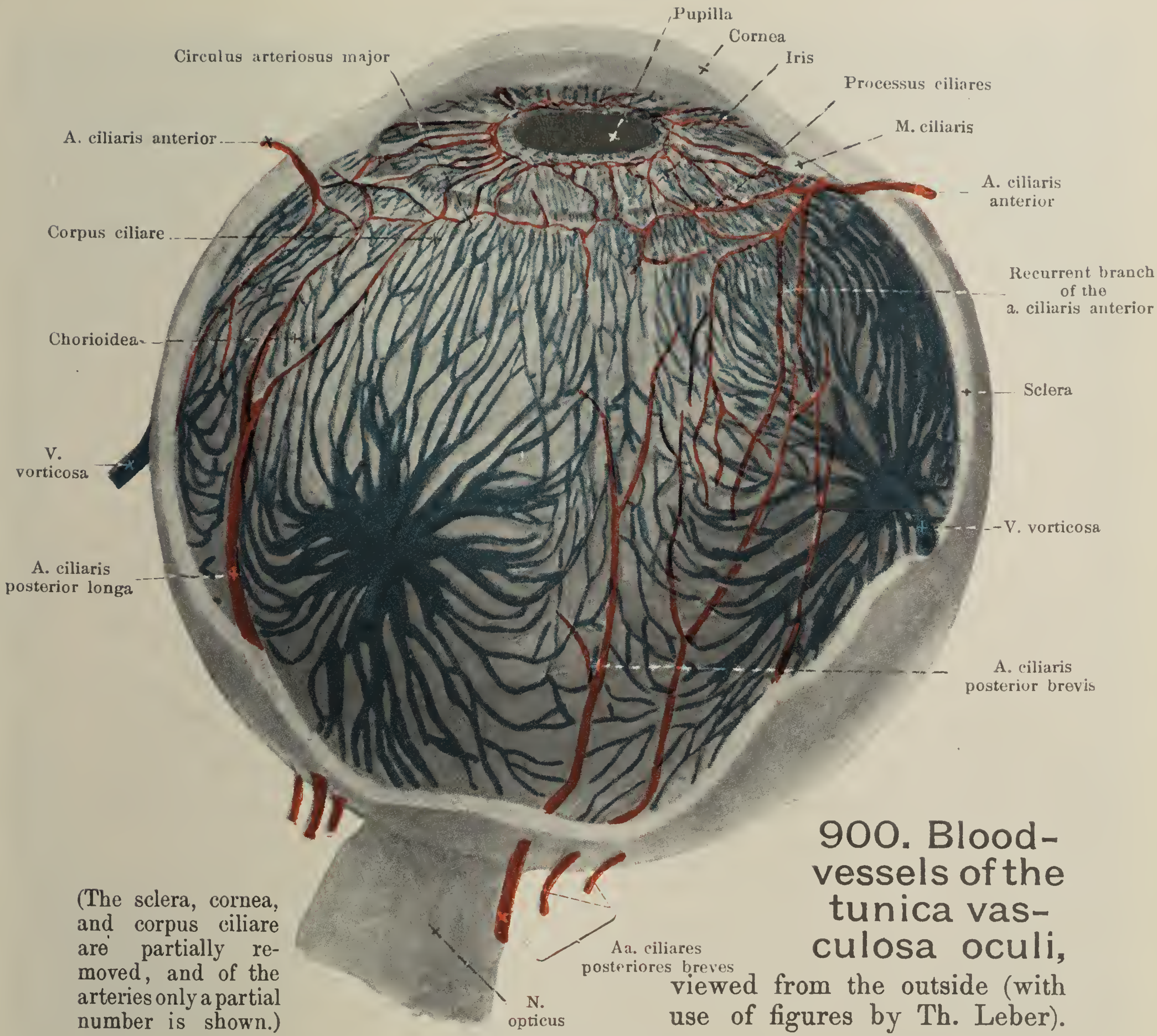
Chorioidea, *choroid coat of the eye* (see Figs. 893, 895, 896, 904 and 905), is very thin, includes approximately the posterior two-thirds of the eyeball, and is sometimes lighter, sometimes darker, according to the amount of pigment it contains. It possesses behind a round opening for the passage of the optic nerve. In it five layers are distinguishable microscopically. Upon the *lamina suprachorioidea* (see p. 798) follows the pigmented *lamina vasculosa* with the coarser vessels, namely the roots of the vv. vorticosae (see Fig. 900) and nerves; then the *layer of medium-sized vessels*, then the non-pigmented *lamina choriocapillaris* with the blood capillaries and upon this the *lamina basalis;* in contact with the latter is the stratum pigmenti of the retina, which remains attached to it even after separation of the retina (during life and after death).

Corpus ciliare, *radiating body*, *ciliary body* (see also Figs. 893, 895—897, 899 and 900), reaches from the ora serrata retinae (see p. 804) to the margo ciliaris of the iris and is lined inside by the *pars ciliaris retinae*, which is but little pigmented on the combs of the ciliary processes and folds. Its posterior portion, *orbiculus ciliaris*, approximately 4 mm broad, differs from the chorioidea essentially by the absence of the lamina choriocapillaris and by the addition of muscle fibres; the inner surface presents fine, meridionally placed, markedly pigmented grooves which often go out from the tips of the teeth of the ora serrata. The anterior portion of the ciliary body forms a three-sided circular ridge parallel to the equator, and is formed chiefly by the m. ciliaris. Its external anterior surface lies against the sclera: its internal surface is united with the margo ciliaris of the iris and otherwise adjoined to the chambers of the eye; its posterior surface adjoins to the vitreous body. From the posterior and internal surfaces about seventy narrow, meridionally placed, glistening white, markedly ridged, very vascular folds, *processus ciliares, ciliary processes,* arise, which are low where they begin laterally and end with a margin projecting internally over the margo ciliaris of the iris (see Fig. 906); in the upper nasal portion they are longer and higher and more widely separated. Between them lie smaller folds, *plicae ciliares.* The totality of processes and folds is called the *corona ciliaris.* The *m. ciliaris* (see Fig. 895) appears as a trilateral-prismatic, light ring of smooth muscle fibres, which arise largely from the internal wall of the sinus venosus sclerae; it is innervated by fibres which arise from the n. oculomotorius and pass the ciliary ganglion. The fibres adjoining the sclera, *fibrae meridionales [Brueckei]* run in a meridional direction and extend as far as into the chorioidea; connected with them are fibres diverging backward in meridional planes and uniting in the form of net-works with one another and with the others; in addition near the inner posterior angle are fibres which run circularly, *fibrae circulares [Muelleri],* especially developed in hypermetropic eyes. In the m. ciliaris the nn. ciliares form a circular plexus, *plexus gangliosus ciliaris* (see Fig. 896), with numerous ganglion cells.


Margin loop network of the cornea
Sinus venosus sclerae [Canalis Schlemmi, Lauthi]
Circulus arteriosus major
A. et v. conjunctivalis anterior
A. ciliaris anterior
Recurrent branch of the a. ciliaris anterior
V. ciliaris anterior
A. ciliaris anterior
A. et v. conjunctivalis posterior
A. episcleralis
V. episcleralis
V. vorticosa
Lamina choriocapillaris
Arteriolae et venulae nasales retinae
Circulus vasculosus n. optici [Halleri]
Aa. ciliares posteriores breves
V. ciliaris posterior
Vessels of the vaginae n. optici
N. opticus
A. centralis retinae
V. centralis retinae
Branch to the circulus vasculosus n. optici [Halleri]
Aa. ciliares posteriores breves
A. ciliaris posterior longa
Iris
Circulus arteriosus major
Corpus ciliare
A. ciliaris anterior
Recurrent branch of the a. ciliaris anterior
Conjunctiva bulbi
A. ciliaris posterior longa
M rectus lateralis
Sclera
Chorioidea
Retina

899. Scheme of the bloodvessels of the eye
(after Th. Leber) (see Fig. 893). Magnification: ca. 4:1.

Iris, ***rainbow coat*** (see Figs. 893, 895 and 896), is a round disc with a round opening, ***pupilla (star of the eye, pupil),*** which usually lies centrally, and not infrequently, deviates from it somewhat downward and nasalward. At its outer, attached margin, ***margo ciliaris,*** it proceeds from the ciliary body, and by its inner, free margin, ***margo pupillaris,*** it rests on the anterior surface of the lens. Its medial margin lies in front of the plane of the fixed margin (see Fig. 893), so that the whole disc has the form of a very flat funnel. On widening of the pupil it becomes narrower and thicker. Its greatest thickness lies near the margo pupillaris and corresponds to the junction between the annuli iridis (vide infra); from there on it diminishes slowly toward the thin margo ciliaris, quicker so toward the margo pupillaris. The anterior surface, ***facies anterior*** (see Figs. 895 and 896), is visible through the cornea as far as the marginal part. It looks blue when pigmentless, gray or gray-green when the stroma contains a little pigment, brown when it contains much pigment; the color is often unsymmetrical, darker near the pupil than in the periphery. Somewhat lateralward from the margo pupillaris runs a jagged line, which separates a narrow, inner zone, ***annulus iridis minor,*** from a broader, outer, ***annulus iridis major.*** In the former, small, anastomosing cords run to the margo pupillaris, which itself is formed by a fine, notched, darkbrown edge belonging to the stratum pigmenti iridis (see Figs. 895 and 896). In the outer zone run in addition to radiating cords (walls of blood-vessels) several usually incompletely circular contraction grooves, ***plicae iridis,*** concentric to the margo pupillaris. Small hollows (crypts) of very varying shape and number are also visible on the anterior surface. The posterior surface of the iris, ***facies posterior,*** is covered by the ***stratum pigmenti iridis,*** is uniformly black and is studded with very fine radiating and finest circular folds.


Pupilla
Cornea
Iris
Circulus arteriosus major
Processus ciliares
M. ciliaris
A. ciliaris anterior
A. ciliaris anterior
Corpus ciliare
Recurrent branch of the a. ciliaris anterior
Chorioidea
Sclera
V. vorticosa
V. vorticosa
A. ciliaris posterior longa
A. ciliaris posterior brevis
Aa. ciliares posteriores breves
N. opticus

(The sclera, cornea, and corpus ciliare are partially removed, and of the arteries only a partial number is shown.)

900. Bloodvessels of the tunica vasculosa oculi, viewed from the outside (with use of figures by Th. Leber).

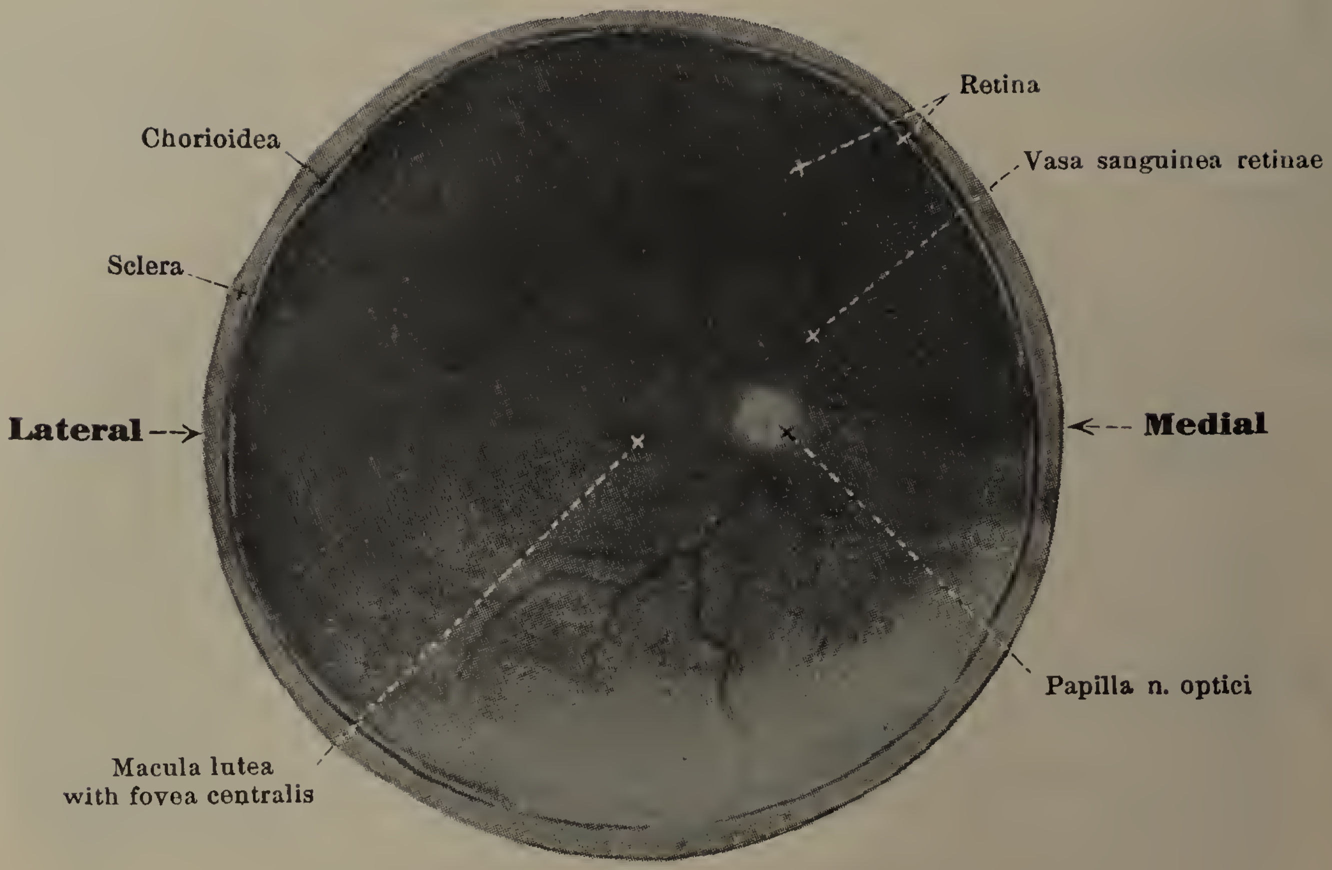
Magnification: ca. 4:1.

Iris (continued) (see Figs. 893 and 895) consists mainly of the soft *stroma iridis* rich in bloodvessels and more or less pigmented; in its posterior part it contains close to the margo pupillaris a circular muscle, *m. sphincter pupillae,* innervated by fibres of the n. oculomotorius which pass the ganglion ciliare, and the fibres of the *m. dilatator pupillae* (innervated by sympathetic fibres of the nn. ciliares longi), diverging from it toward the periphery: the latter are differentiated parts of the cells of the anterior layer of the stratum pigmenti iridis from which develop all the muscle fibres of the iris.

The groove in front of the margo ciliaris iridis is called the *angulus iridis* (see Fig. 895 and p. 807). It is bounded externally by a network of circular strands covered by endothelium, the *lig. pectinatum iridis;* between the strands are oblong spaces, *spatia anguli iridis [Fontanae].* This network of strands forms the inner boundary of the sinus venosus sclerae (see pp. 797 and 802), is connected in front with the deepest layer of the cornea, behind with the margo ciliaris iridis and gives origin to a large part of the m. ciliaris.

Bloodvessels of the tunica vasculosa oculi. A. *Arteries* (see also Fig. 899).

1. *Aa. ciliares posteriores breves* (see also p. 416) give fine branches to the posterior half of the external surface of the sclera and perforate the sclera by about twenty branches in the neighborhood of the n. opticus; they run forward in the lamina vasculosa chorioideae and break up in the close capillary network of the lamina choriocapillaris. In front they unite with fine, recurrent branches of the aa. ciliares posteriores longae and ciliares anteriores. Some branches from these vessels in the sclera close to the exit of the n. opticus form a closed, vascular circle, *circulus vasculosus n. optici [Halleri],* from which branches enter into the n. opticus and anastomose with branches of the a. centralis retinae.



901. Posterior half of a right eye, viewed from in front. Magnification: 4:1.

2. *Aa. ciliares posteriores longae* (see p. 416 and Figs. 899 and 900), two, perforate the sclera very obliquely in the neighborhood of the n. opticus and in the horizontal meridian, one on the lateral, the other on the medial side of the eyeball, pass forward in the lamina suprachorioidea as far as the corpus ciliare. There each divides into two diverging branches, which near the margo ciliaris iridis along with the branches of the other corresponding artery and with those of the aa. ciliares anteriores form a large, circular anastomosis, *circulus arteriosus major* (see also Fig. 895), and which give branches to the m. ciliaris.

3. *Aa. ciliares anteriores* (see p. 416 and Figs. 899 and 900), usually 5—6, give off on the external surface of the sclera 1. backward fine branches, *aa. episclerales*, to the anterior half of the same and 2. forward branches, *aa. conjunctivales anteriores*, to the conjunctiva bulbi, which anastomose with the aa. conjunctivales posteriores from the aa. palpebrales mediales and laterales (see pp. 416 and 417) and give off fine branches to the extraordinarily delicate marginal *loop network of the cornea*, situated in the annulus conjunctivae. They then perforate the sclera with 8—10 branches in the region of the m. ciliaris, send branches to this and enter the *circulus arteriosus major* (vide supra). From this branches pass to the m. ciliaris, to the processus ciliares, as well as recurrently to the union with the aa. ciliares posteriores breves; besides, numerous branches pass out of it into the iris and run in its anterior layers toward the margo pupillaris, part of them reaching this, part of them branch off shortly before this without anastomosing with one another.

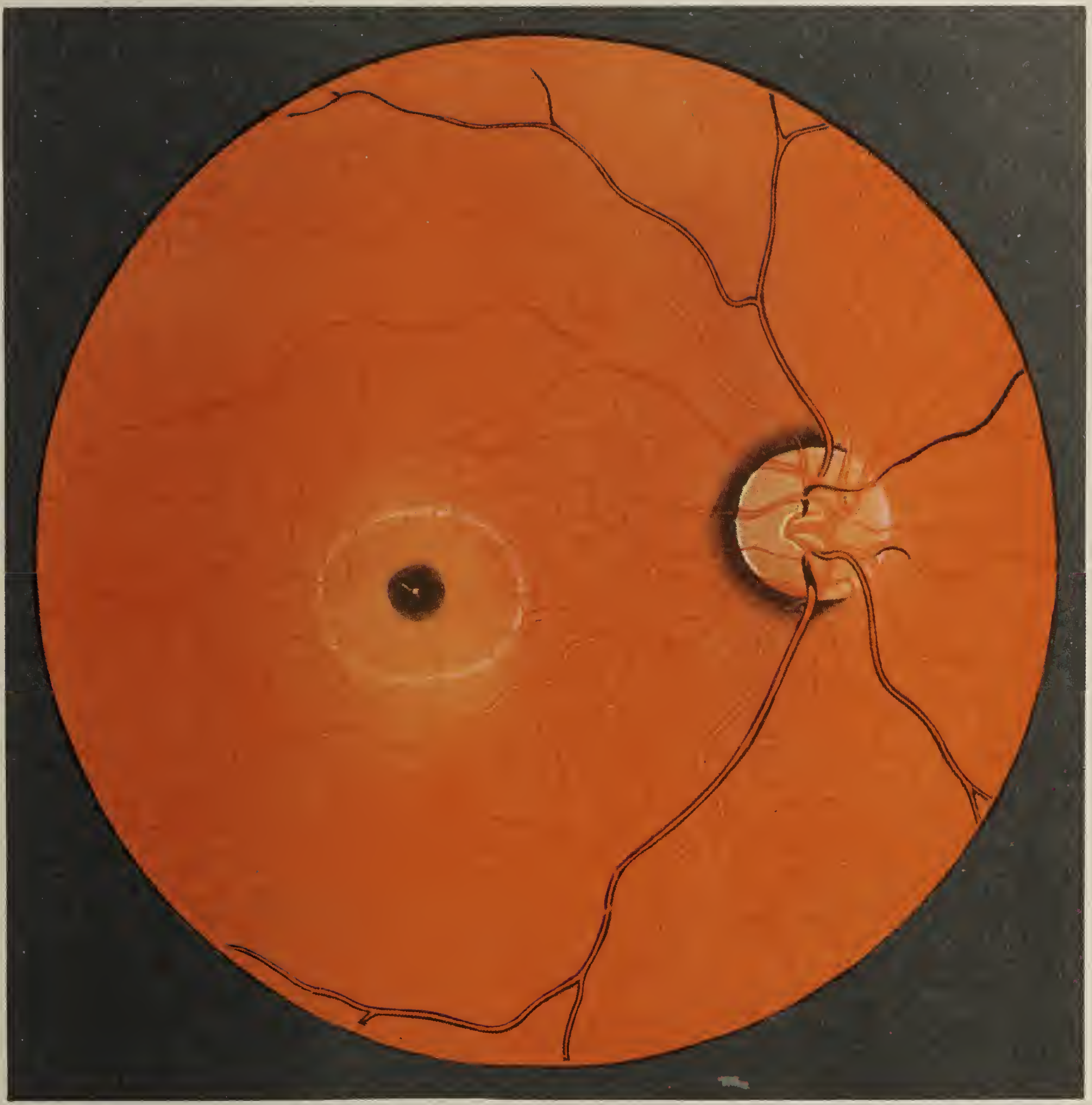
B. *Veins* (see pp. 460 and 461 and Figs. 899 and 900).

1. *Vv. vorticosae*, 4, more rarely 5 or 6, form the chief channels of exit for the blood; they arise by the running together, in groups radially toward 4 (5 or 6) spots on the equator, of the veins proceeding from the capillary network of the lamina choriocapillaris, and of numerous large branches from the corpus ciliare and from the iris in the lamina vasculosa chorioideae; they then perforate the sclera very obliquely and open into a v. ophthalmica.

2. *Vv. ciliares anteriores* perforating the sclera near the aa. ciliares anteriores, are numerous derivatives of the *sinus venosus sclerae [canalis Schlemmi, Lauthi]* (see also p. 797 and Fig. 895), a circular venosus plexus, which receives small branches from the m. ciliaris. Upon the sclera they receive farther the *vv. conjunctivales anteriores* and *vv. episclerales*, corresponding to the arteries of the same name. They open into the veins of the mm. recti of the eye.

3. *Vv. ciliares posteriores* collect the blood near the n. opticus upon the external surface of the sclera from the vessels situated upon the surface of the latter and anastomose in front just as do the vv. episclerales with the vv. vorticosae. They therefore do not correspond to the aa. ciliares posteriores.

Nerves of the eyeball. The *nn. ciliares longi* and *breves* (see p. 714) perforate the sclera with about 20 branches in the neighborhood of the n. opticus, run forward in the lamina suprachorioidea, form the *plexus gangliosus ciliaris* (see p. 799 and Fig. 896) in the m. ciliaris, and send branches to the chorioidea, sclera, cornea, corpus ciliare and iris.



902. Background of a living right eye.
(After J. Oeller.)

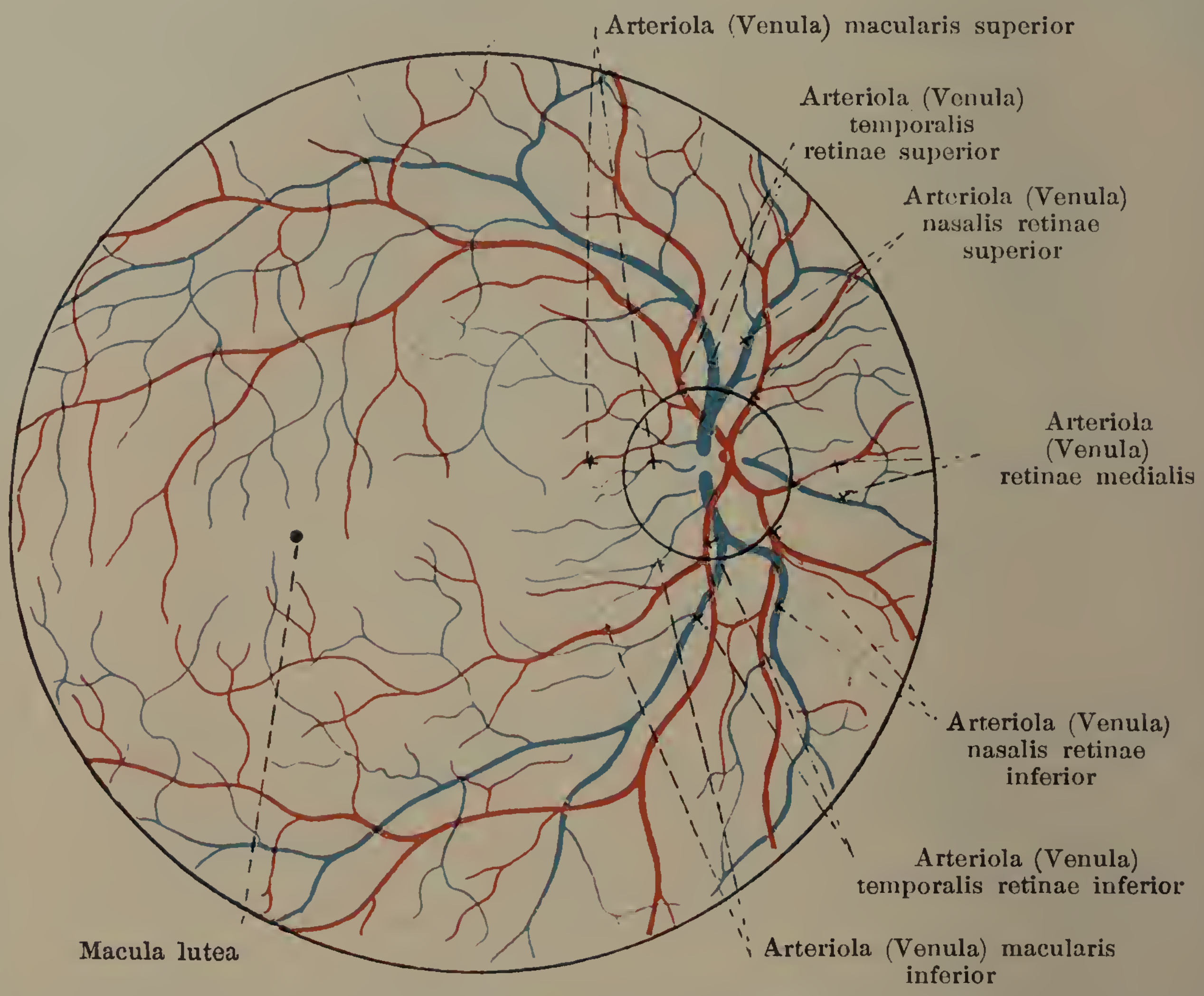
(The vv. vorticosae are partially visible as light stripes; the arteries of the retina look lighter than the veins.)

Retina (see also Figs. 893, 895, 897—899, 901 and 903—905) lies everywhere directly adjacent internally to the tunica vasculosa oculi, and is divisible into a larger posterior portion, ***pars optica retinae***, which contains the expansion of the n. opticus, as well as the sensory epithelium, sensitive to light, and a smaller anterior portion, ***pars ciliaris retinae***, which belongs to it embryologically, but which possesses neither nerves nor elements sensitive to light. The junction between the two portions is formed by the *ora serrata* (see p. 804).

The *pars optica retinae* is smooth and transparent like glass in the living eye and permits the stratum pigmenti and the chorioidea lying external to it to appear as dark-red surfaces, their distinctly visible details varying according to the pigmentation; the blood-vessels of the retina lie internally upon it.

903. Blood vessels of the retina of the right eye,

viewed from in front (after E. Jäger and Th. Leber).

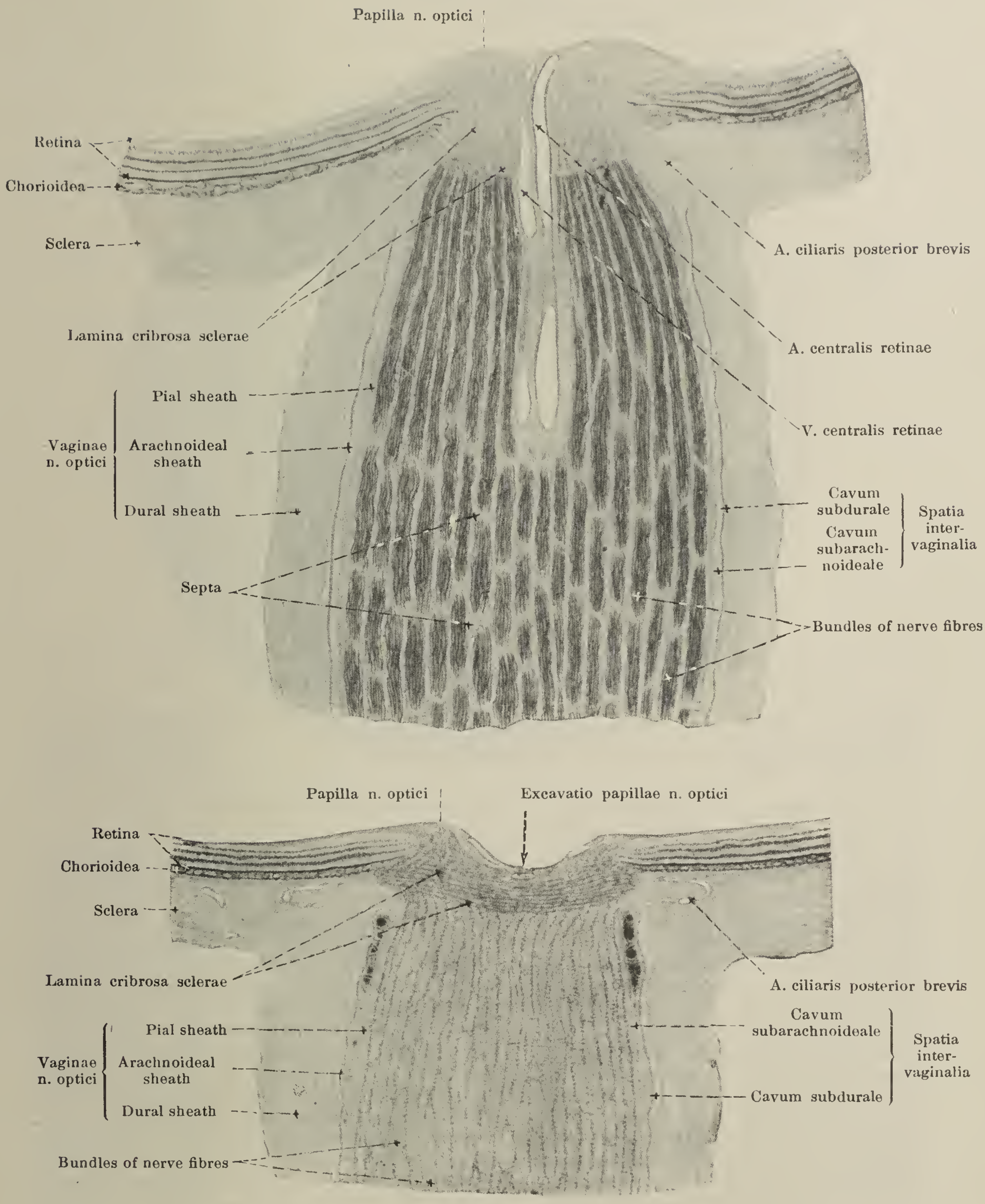

Arteriola (Venula) macularis superior
Arteriola (Venula) temporalis retinae superior
Arteriola (Venula) nasalis retinae superior
Arteriola (Venula) retinae medialis
Arteriola (Venula) nasalis retinae inferior
Arteriola (Venula) temporalis retinae inferior
Arteriola (Venula) macularis inferior
Macula lutea

Pars optica retinae (continued) (see Figs. 893, 895, 897, 898, 901, 902, 904 and 905). Its thickness diminishes slowly from the papilla n. optici (vide infra) forward. The n. opticus after perforating the sclera, chorioidea and retina arrives on the inner surface of the retina, whence it spreads out on all sides; the place where it enters, situated medianward from the posterior end of the axis oculi externa and somewhat below it, has the form of a rounded hillock, *papilla n. optici* (see Figs. 893, 901, 902, 904 and 905), which is slightly depressed in the middle, or presents a fossa-like depression, *excavatio papillae n. optici (physiological excavation)*, reaching as far as the level of the chorioidea; the papilla appears during life as a circular, whitish spot from the middle of which the blood-vessels of the retina emerge. About 4 mm lateralward from the centre of the papilla and a little deeper down lies a pin-prick-like depression, the *fovea centralis* (see Figs. 893, 901 and 902), in the middle of the circular or transversely oval, not sharply defined, yellow-colored *macula lutea, yellow spot.* The anterior boundary of the pars optica is formed by the *ora serrata* (see Figs. 893, 895, 897 and 898). This is a line with minute outward curved projections, which reaches somewhat more forward on the nasal side than on the temporal side, but otherwise varies extraordinarily in its appearance. Its teeth directly toward the corpus ciliare are rarely even in the whole circumference; they are more often better developed nasalward than temporalward and are often directed toward the interspaces between the processus ciliares.

The *pars ciliaris retinae* (see Fig. 895), a microscopically thin layer, covers the posterior surface of the corpus ciliare and of the iris as far as its margo pupillaris; it is formed 1. by the stratum pigmenti corporis ciliaris et iridis (vide infra) and 2. by an inner layer of cells, which is also pigmented on the iris, but is colorless on the corpus ciliare.

The outermost layer of the retina, which lies directly in contact with the tunica vasculosa, consists of a simple layer of pigmented cells, *stratum pigmenti,* which is designated on the pars optica retinae as the *stratum pigmenti retinae*, on the pars ciliaris retinae as the *stratum pigmenti corporis ciliaris* (see p. 799) and *stratum pigmenti iridis.*

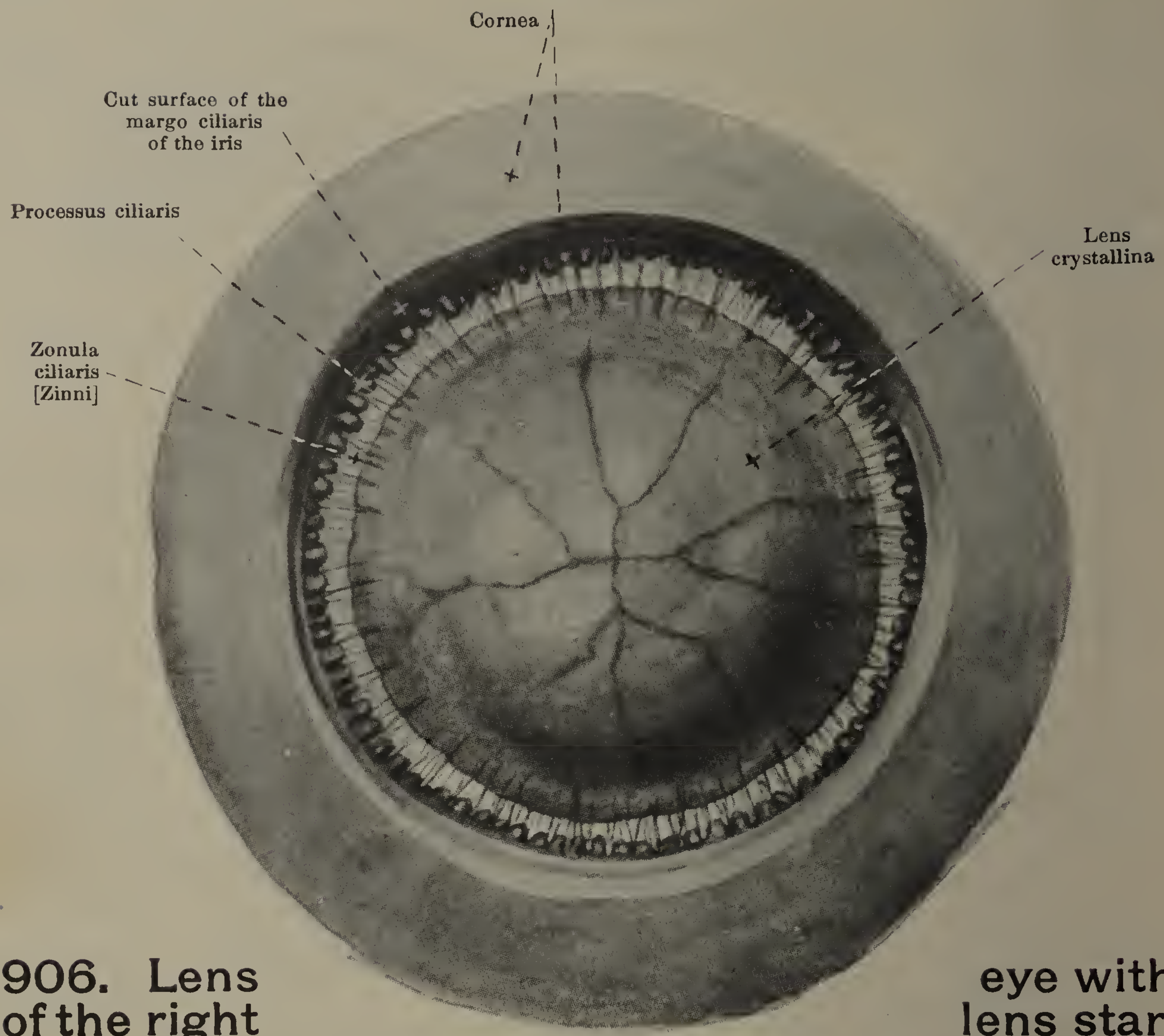
Vasa sanguinea retinae (see also Figs. 899 and 902) are branches of the a. and v. centralis retinae (see pp. 416, 460, 795), the larger branches of which lie in the layer of optic nerve fibres; arteries and veins run almost parallel with one another. The arteries of the retina do not anastomose with one another. Aside from the anastomoses with the aa. ciliares posteriores breves, mentioned on p. 801, they are completely separate from the vessels of the tunica vasculosa. The a. and v. centralis retinae divide on the surface of the papilla, or somewhat deeper, first into an upper and a lower branch, and each of these divides again into a shorter branch running nasalward, *arteriola (venula) nasalis retinae superior, inferior,* and a lateral, longer, *arteriola (venula) temporalis superior, inferior.* In addition two small vessels run from the papilla lateral to the macula lutea, *arteriola (venula) macularis superior, inferior,* and usually one vessel medianward, *arteriola (venula) retinae medialis.*



904 and 905. Longitudinal sections of the n. opticus and of the papilla n. optici,

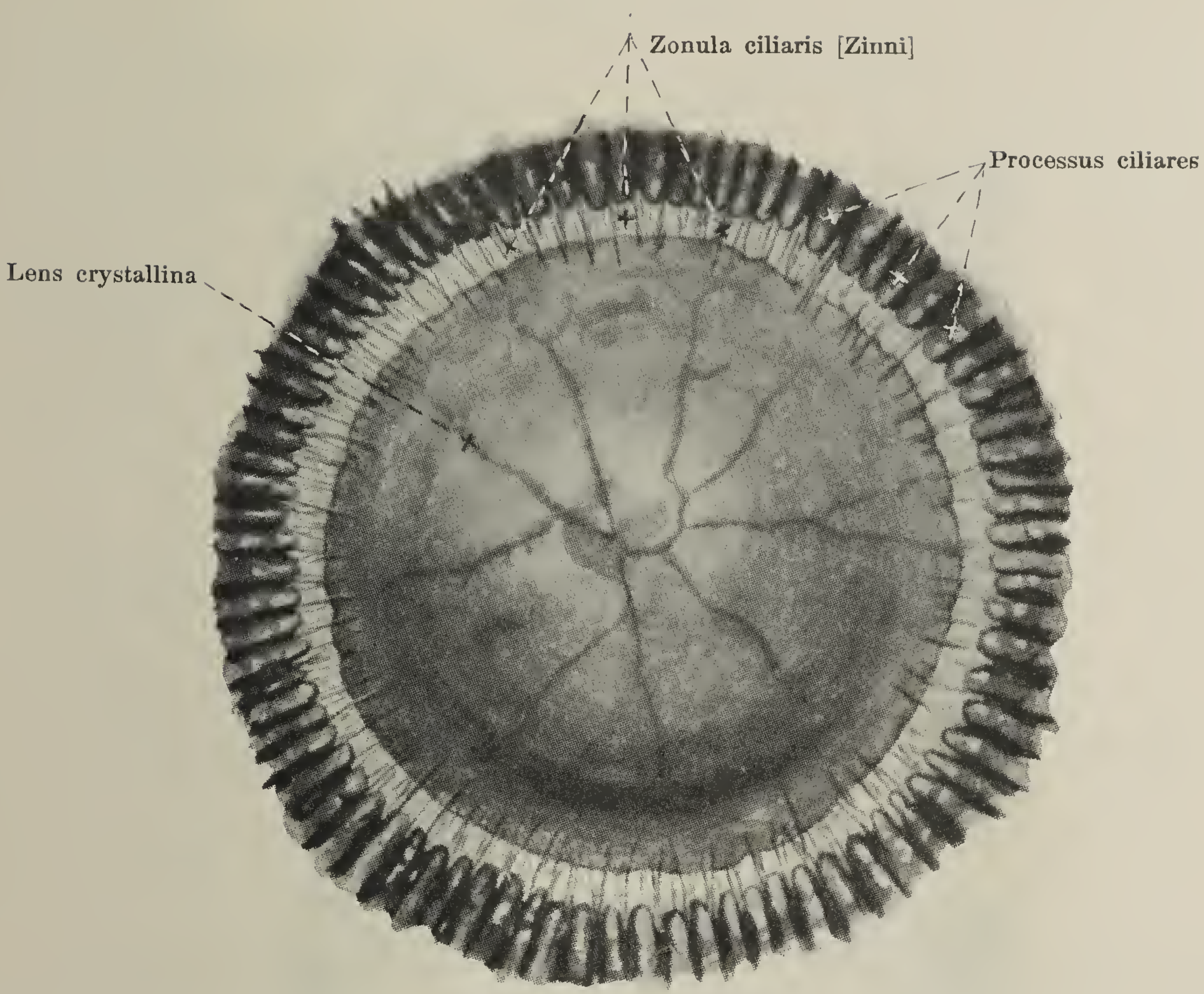
the upper without, the lower with the excavatio papillae n. optici (after preparations by H. Sattler). Magnification: 15:1.

(On the upper figure the medullated portions of the nerve fibres are shown dark; the lower section has not been cut axially.)



906. Lens of the right eye with lens star, viewed from in front, after removal of the cornea and iris (from a photograph by M. Wolfrum). Magnification: 6 : 1.

Lens crystallina, *lens* (see also Figs. 893, 895—897 and 907—910), is a very transparent, colorless, biconvex body, the two surfaces of which meet in a rounded, sometimes jagged margin, *aequator lentis.* The anterior surface, *facies anterior lentis,* is more feebly curved than the posterior surface, *facies posterior lentis,* neither corresponding, however, exactly to a portion of a spherical surface. Besides, the radius of the middle part of the lens surfaces differs according as the eye is fixed for near or distant objects; the radius of the anterior surface on fixation for distant objects, is 8.3 mm, for near 5.2 mm, the radius of the posterior surface on fixation for distance 6.0 mm, for near 5.0 mm. The midpoint of the anterior surface is called the *polus anterior lentis,* that of the posterior surface the *polus posterior lentis,* the straight line uniting the two is called the *axis lentis* and on fixation for distant objects is 3.7 mm, for near 4.4 mm long. The equatorial plane of the lens stands perpendicular to the axis of the eye, in the plane of the corpus ciliare. The lens is there held in position by the *zonula ciliaris [Zinni]* (see p. 807); its anterior surface touches the posterior surface of the margo pupillaris of the iris, and its posterior surface lies in the fossa hyaloidea of the corpus vitreum (see p. 807). The lens substance, *substantia lentis,* is ensheathed by a structureless membrane (thicker in front), *capsula lentis,* and consists of a softer, juicier cortical layer, *substantia corticalis,* and a firmer nucleus, *nucleus lentis,* which gradually go over into one another, their relations varying in different individuals. The lens substance consists of the one-layered cubical *lens epithelium, epithelium lentis,* covering its anterior surface, and the band-like *lens fibres, fibrae lentis,* making up the remaining mass, the two merging at the equator. These fibres run in curves from points in front of the equatorial surface to points behind it, in that way that fibres which originate in front near the pole, end behind far from it and vice versa. They are attached in front and behind to stellate collections of intercellular substance, which on maceration of the lens open up as slits. These *lens stars* have three rays, *radii lentis,* in the fetus and new-born, of which one on the anterior surface is directed upward, the others downward and medianward and downward and lateralward; on the posterior surface they are displaced by 60°.



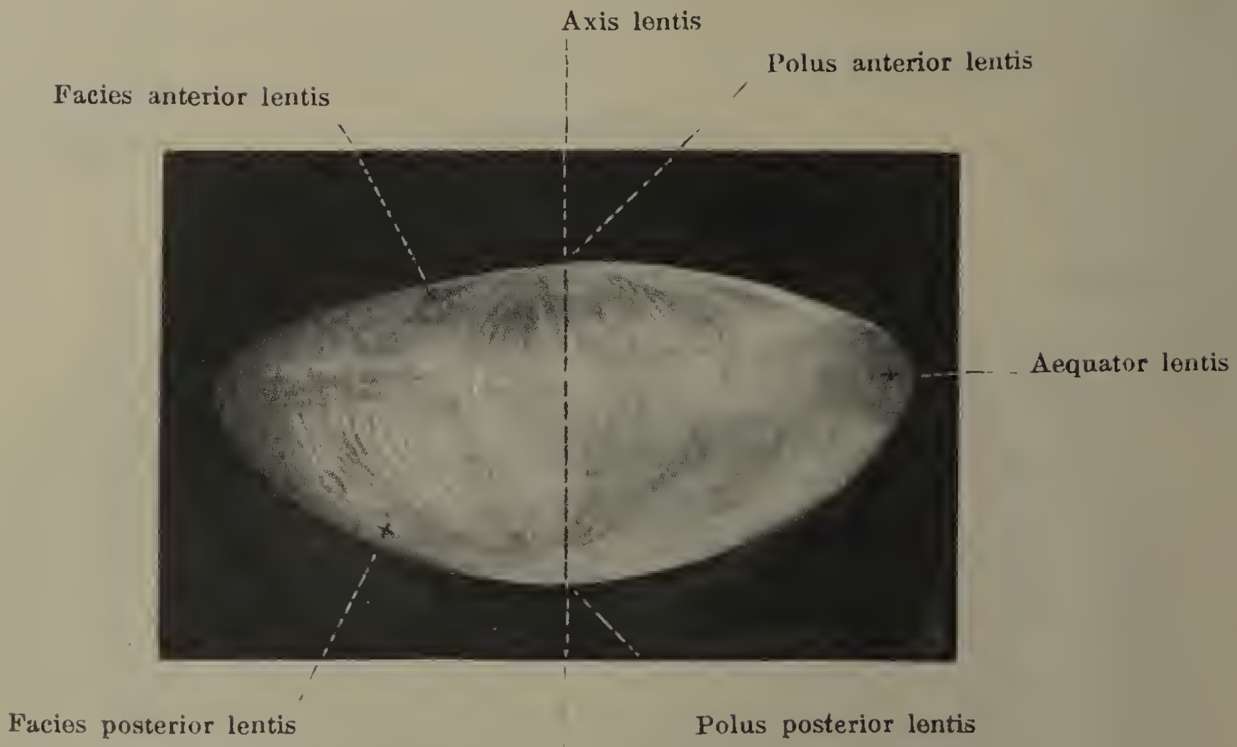
907. Lens of the right eye with lens star, viewed from behind, after removal of the cornea and iris (after C. Rabl). Magnif.: 6 : 1.

Lens crystallina (continued) (see also Fig. 906). The *lens star* of the adult usually presents in the nucleus the triradiate type; in the external layers it is nine- to twelve-rayed, alternating usually on the anterior and posterior surfaces so that one anterior ray lies in the middle between two posterior and vice versa.

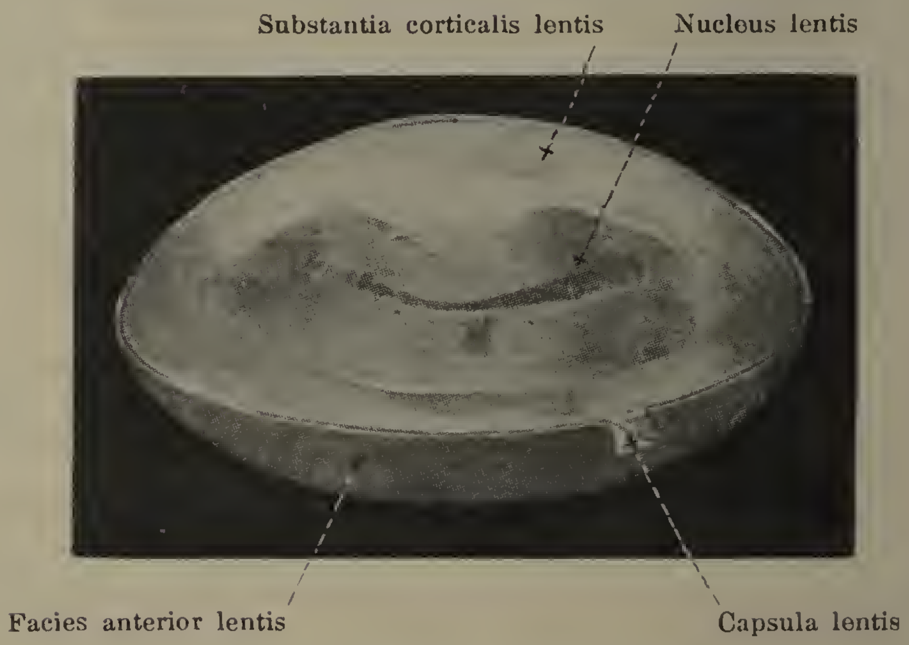
The **zonula ciliaris [Zinni],** *radiate platelet* (see also Figs. 893, 895 and 906), is the suspensory apparatus of the lens and consists of innumerable extremely fine fibrils, *fibrae zonulares,* which originating in the cells of the pars ciliaris retinae in the region of the ora serrata, of the orbiculus ciliaris and the corpus ciliare, stretch radially to the equator of the lens and there enter the capsula lentis. In so doing they run only in the grooves between the processus ciliares. The fibres arising behind are distributed in several bands over the whole equator, those arising in front reach the lens behind it; accordingly the fibres undergo partial decussation. The large spaces between the fibres, *spatia zonularia,* are filled with aqueous humor and communicate freely among one another and with the part of the posterior chamber of the eye lying in front of them; behind they adjoin the anterior surface of the vitreous body.

Humor aqueus, *aqueous humor,* is a fluid, poor in albumen, which fills up the space between the anterior surface of the lens (and of the vitreous) and the posterior surface of the cornea. It is subject to a slow but steady flow, is probably produced mainly by the processus ciliares and is led away by filtration into the sinus venosus sclerae. The space filled with aqueous humor is divided by the iris into two compartments, the *camera oculi posterior* and *camera oculi anterior, posterior* and *anterior chambers of the eye* (see Figs. 893 and 895). The former includes also the spatia zonularia and is bounded behind by the vitreous booy, externally by the inner surface of the corpus ciliare and of the processus ciliares, in front by the iris and internally by the lens. The anterior chamber of the eye is surrounded in front by the cornea, behind by the iris and by that part of the anterior surface of the lens visible in the pupil; its gutter-like lateral margin which in front touches the cornea, behind the iris, and externally the lig. pectinatum iridis, is called the *angulus iridis* (see also p. 801).

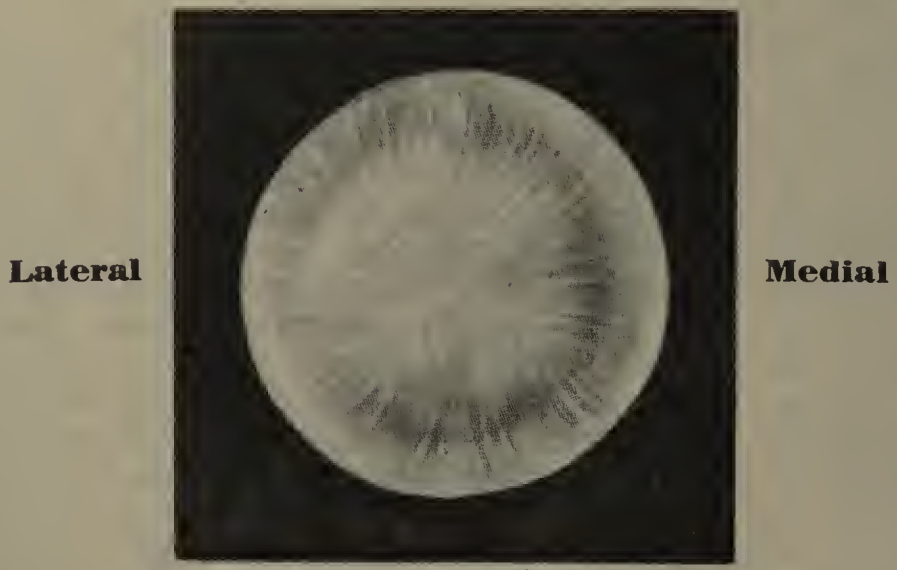
Corpus vitreum, *vitreous* or *glassy body* (see Fig. 893), a colorless, transparent, gelatinous body, fills up the space between the retina and the lens, reaches forward as far as the zonula ciliaris and presents a fossa-like depression, *fossa hyaloidea,* for the reception of the posterior surface of the lens. It connects externally with the innermost layer of the retina and consists of a frame-work of very fine fibres, *stroma vitreum,* the meshes of which are filled with fluid, *humor vitreus.*



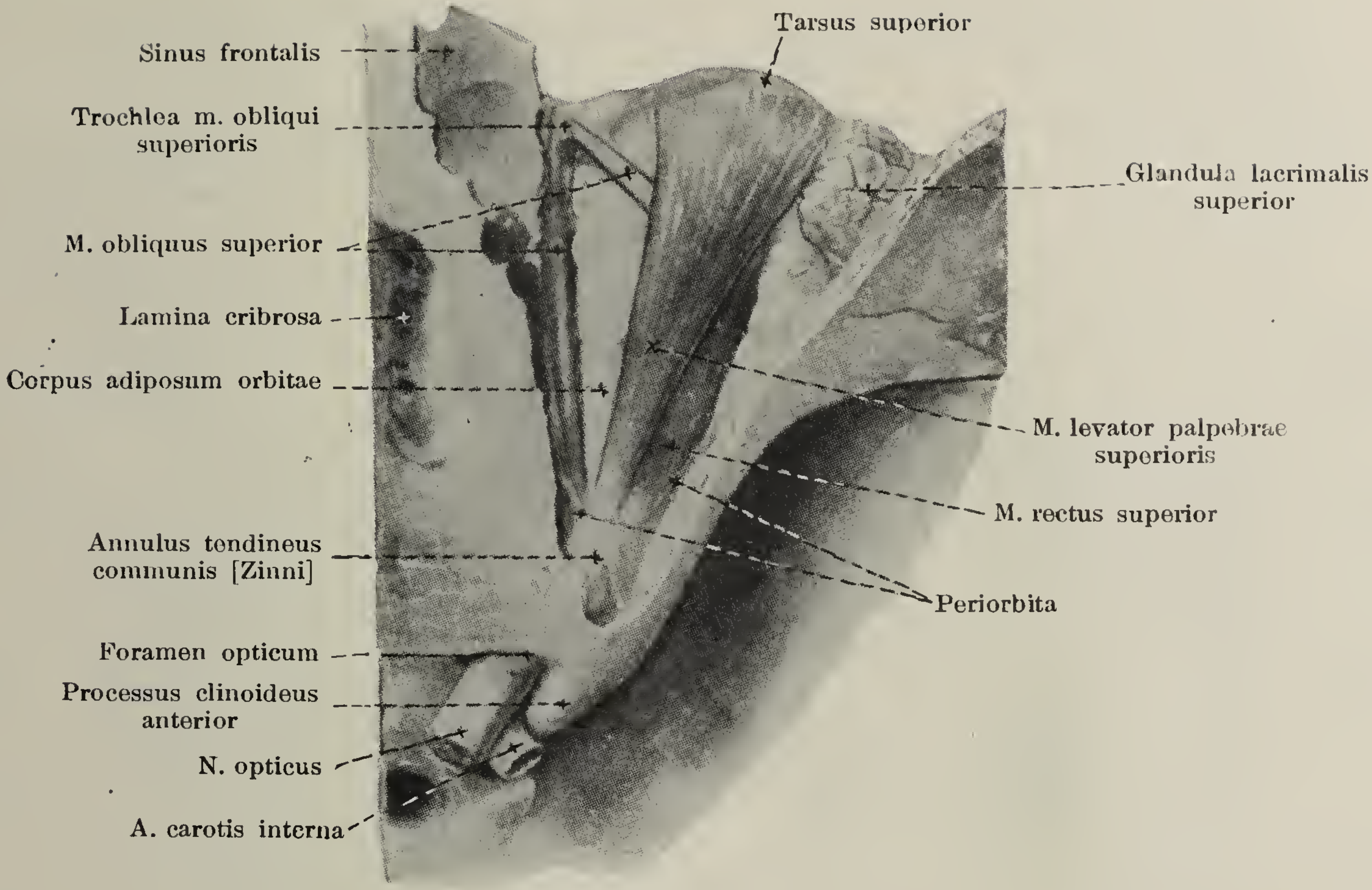
908. Lens, viewed from above. Magnification: 6 : 1.



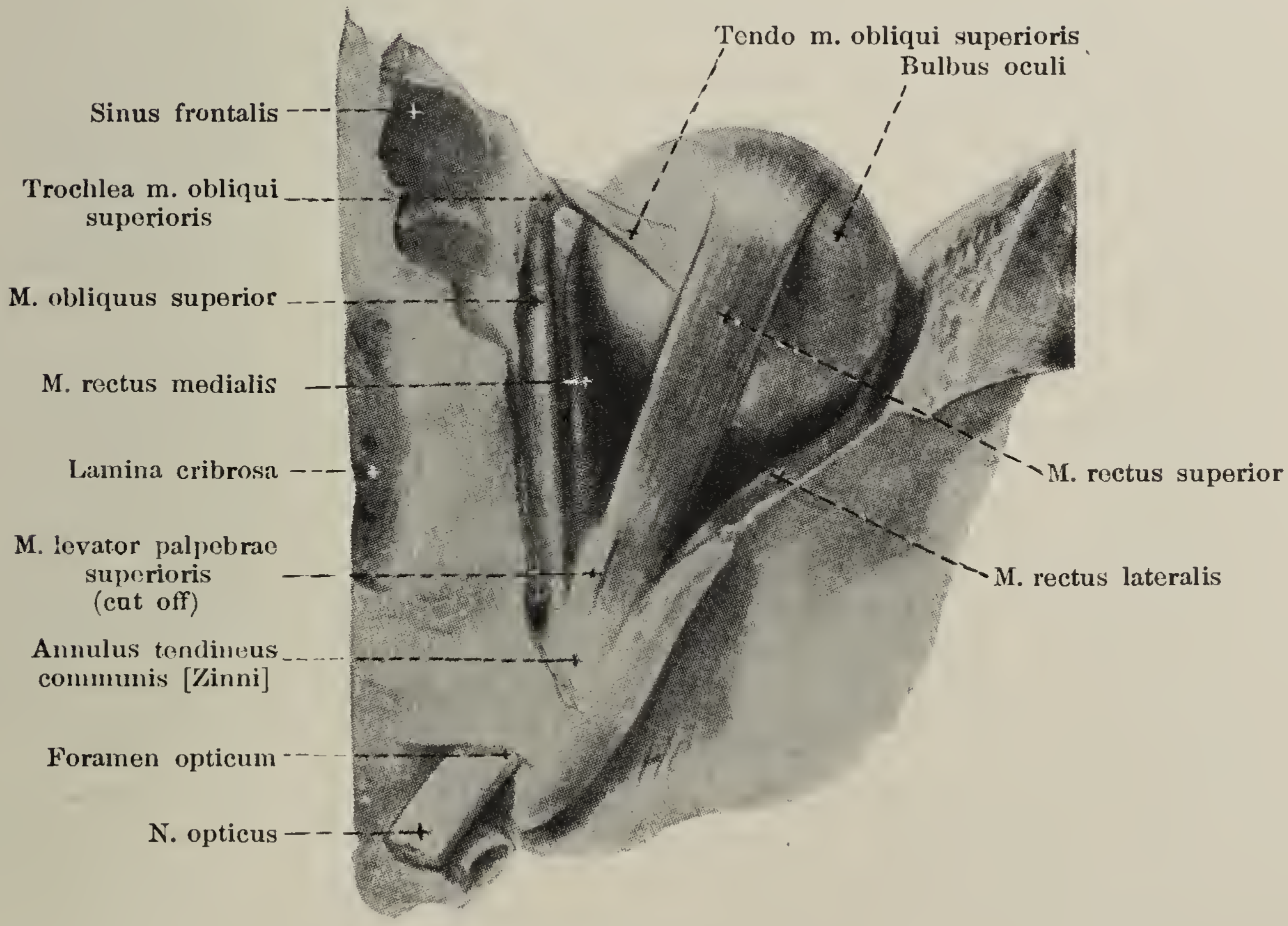
909. Lens, cut through horizontally. Magnification: 6:1.
(The capsule of the lens has been loosened somewhat.)



910. Lens of a seven months' fetus, viewed from in front. Magnification: 6 : 1.



911. Contents of the right orbital cavity, viewed from above.

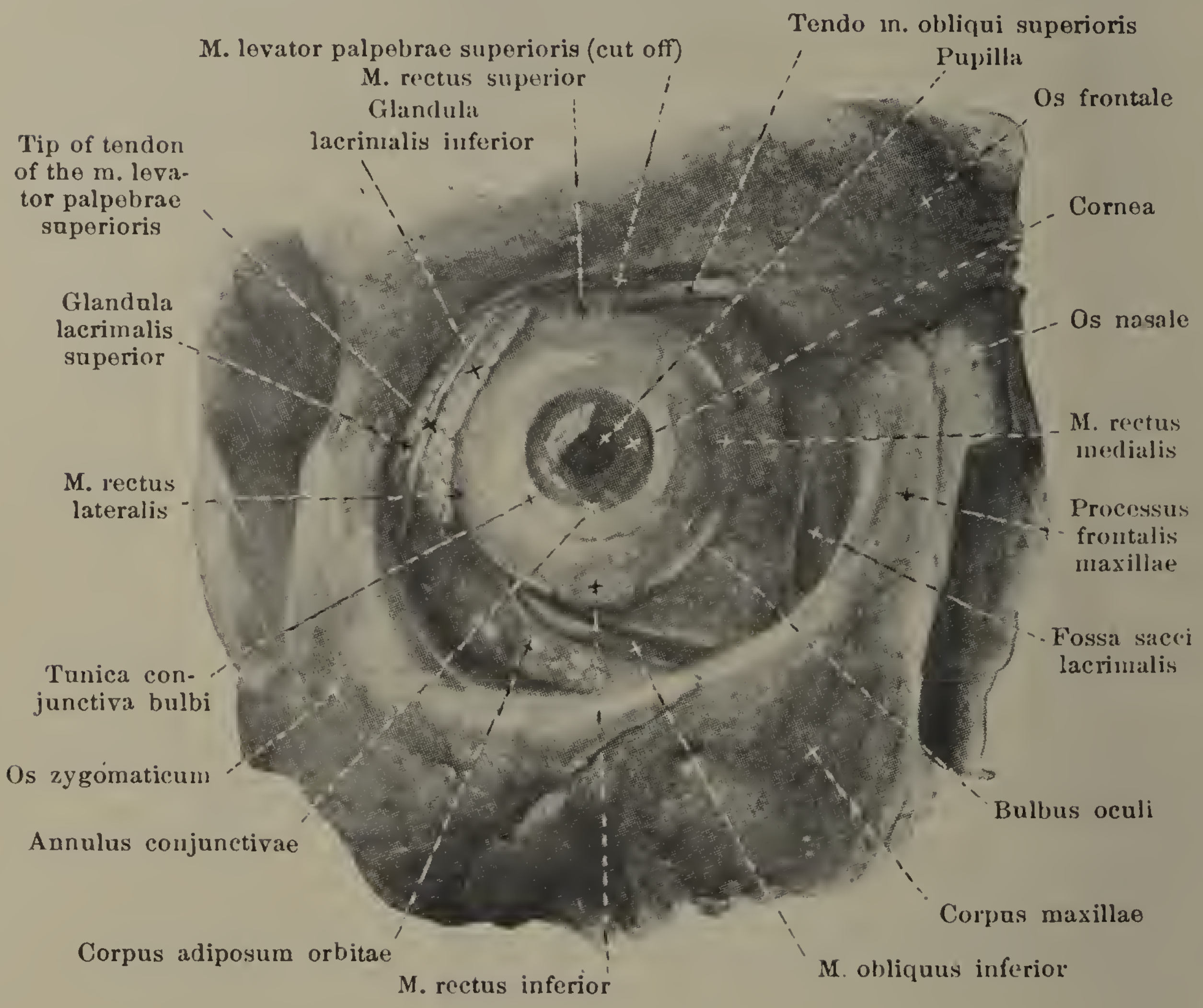


912. Muscles of the right eye, viewed from above.
(The m. levator palpebrae superioris, the corpus adiposum orbitae, the lachrymal gland and the eyelids have been removed.)

913. Contents of the right orbital cavity,

viewed from in front.

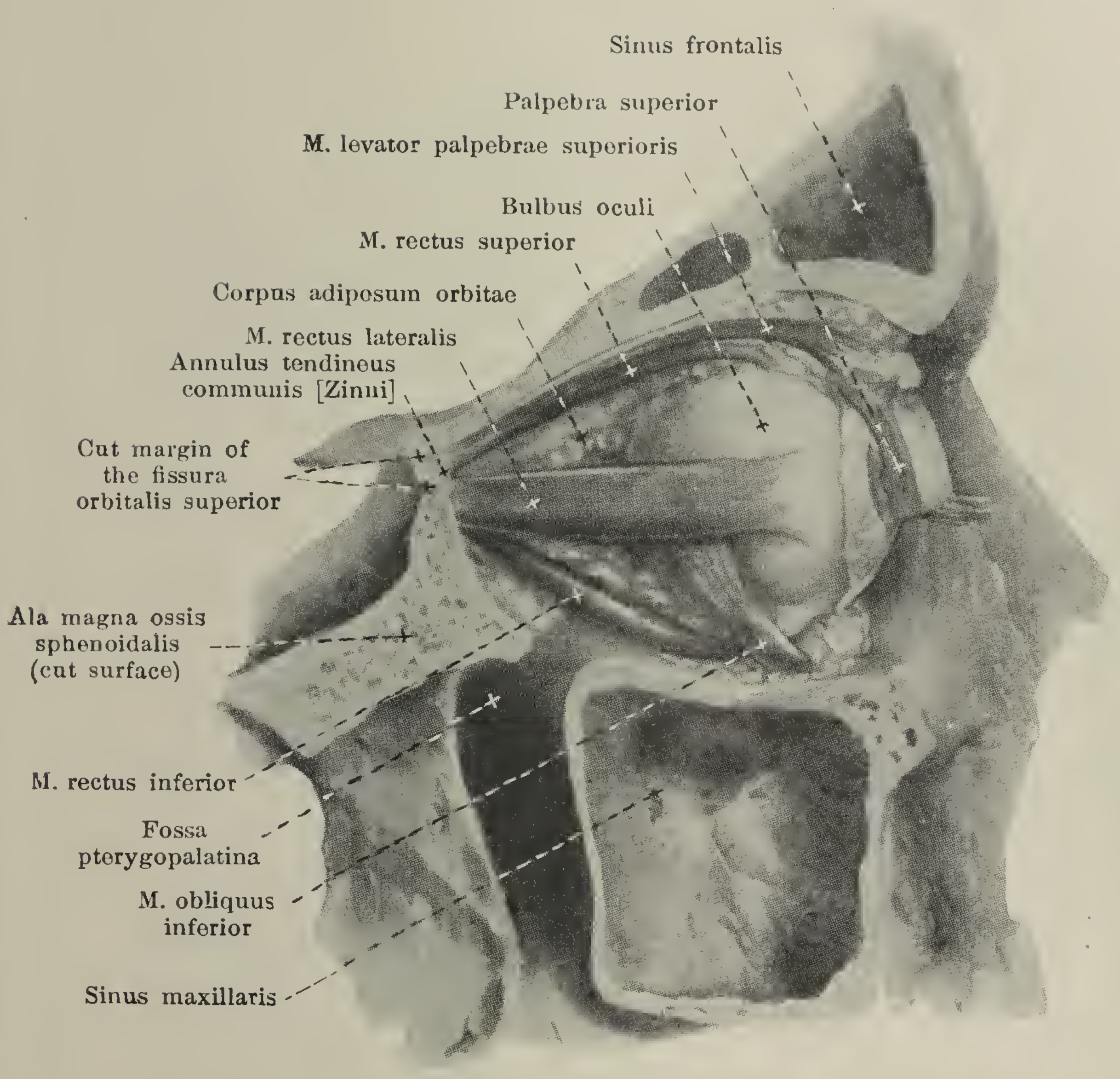
(The eyelids along with the tear sack and lachrymal canal have been removed.)



Musculi oculi, muscles of the eye (see also Figs. 911, 912 and 914—924). The mm. recti arise by a funnelshaped tendinous ring, *annulus tendineus communis [Zinni]* (see Figs. 911, 912 and 916), which passes around the upper medial margin of the foramen opticum and is attached lateralward to a bony process of the facies orbitalis alae magnae ossis sphenoidalis; it is very firmly connected with the dural sheath of the n. opticus, and with the tough membrane formed by the union of the periorbita with the dura mater encephali which closes the fissura orbitalis superior, and its transversely oval lumen surrounds the foramen opticum (with the n. opticus and the a. ophthalmica) and a part of the fissura orbitalis superior (with the nn. oculomotorius, nasociliaris and abducens). Of this tendinous ring (see Fig. 916) the origins of the mm. recti superior, medialis, inferior, lateralis take the superior, medial, inferior, lateral part; the origin of the m. rectus lateralis is strengthened by a second head, which arises through the *lacertus musculi recti lateralis* somewhat lateralward on the facies orbitalis of the ala magna oss. sphenoidalis. The m. levator palpebrae superioris arises immediately above the tendinous ring, and is there fused with it. The origin of the m. obliquus superior lies medial on the body of the sphenoid bone a little in front of the foramen opticum and above joins the origin of the preceding muscle.

1. *M. levator palpebrae superioris* (see also Figs. 911, 912, 914—916 and 920—924). Form: oblong-triangular, flat. Position: chiefly directly beneath the upper wall of the orbit. Origin: annulus tendineus communis [Zinni] (vide supra). Insertion: it passes from the equator of the bulbus in a curve downward and divides into two lamellae. The stronger, posterior, is attached fan-like to the whole upper margin of the tarsus superior and contains smooth muscle fibres, *m. tarsalis superior* (see also p. 820 and Figs. 924 and 930). The anterior lamella passes together with the septum orbitale in front of the tarsus downward and forward, attaches on the lateral wall of the orbit and sends bundles through the septum orbitale and the m. orbicularis oculi to the skin of the lid (to the sulcus orbitopalpebralis superior). Action: lifts the upper eyelid and causes the superior palpebral fold (see p. 821). Innervation: n. oculomotorius.

2. *Mm. recti* (see also Figs. 911—912 and 914—924) are oblong, flat muscles of parallel fibres, narrow behind and broad in front which all arise from the annulus tendineus communis [Zinni] (see above); they run forward close to the orbital wall (the upper one separated from it by the m. levator palpebrae superioris), pass in its anterior half through the fat body toward the eyeball, are situated upon it for some distance from the region of the equator on, and go over by broad, thin tendons in front of the equator into the sclera. The longest of them is the superior, next comes the medial, then the lateral, then the inferior. The mode of action of the mm. recti superior et inferior and of the mm. obliqui depends on the size of the angle between the visual line and the course of the muscle.



914.

Contents of the right orbital cavity,

viewed from the right.

(The glandulae lacrimales and the lower eyelid have been removed; the muscles are exposed.)

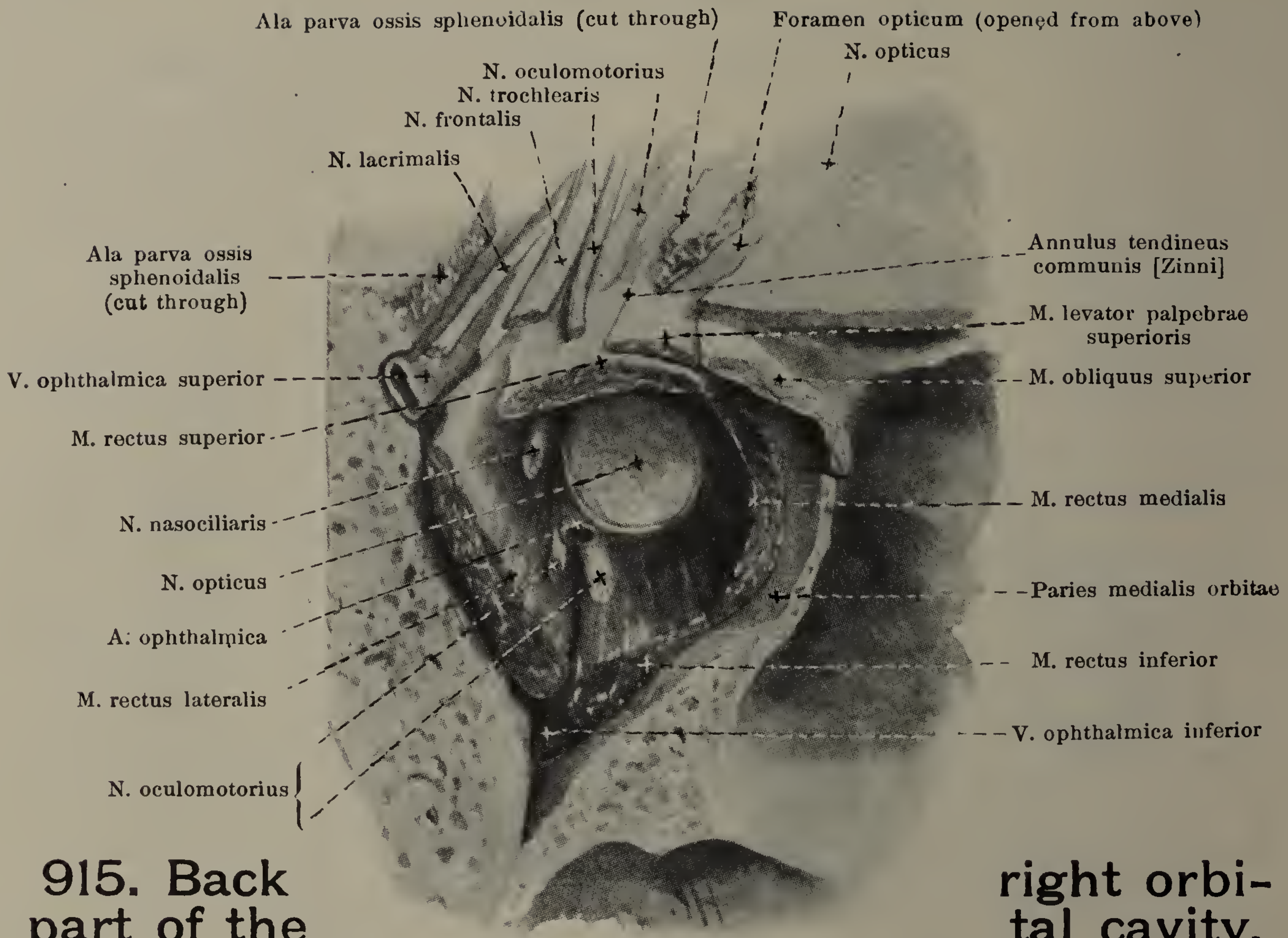
a) *M. rectus superior.* Position: just beneath the m. levator palpebrae superioris, projecting beyond it behind and lateralward; it passes forward and lateralward and forms an angle of about 25° with the visual line directed straight forward. Insertion: on the average 7.75 mm from the margin of the cornea; the line of insertion is 10.8 mm long, curved so as to be slightly convex forward, asymmetrical, oblique. Action: it draws the anterior pole upward and medianward and rolls the upper pole medianward. The influence of the elevating component is greatest on looking lateralward, that of the rotating on looking medianward. Innervation: n. oculomotorius.

b) ***M. rectus medialis*** (O. T. internal rectus). Position: on the medial wall of the orbital cavity. Insertion: on the average 5.5 mm from the margin of the cornea; the line of insertion is 11 mm long, curved so as to be slightly convex forward, usually symmetrical. Action: turns the anterior pole medianward. Innervation: n. oculomotorius.

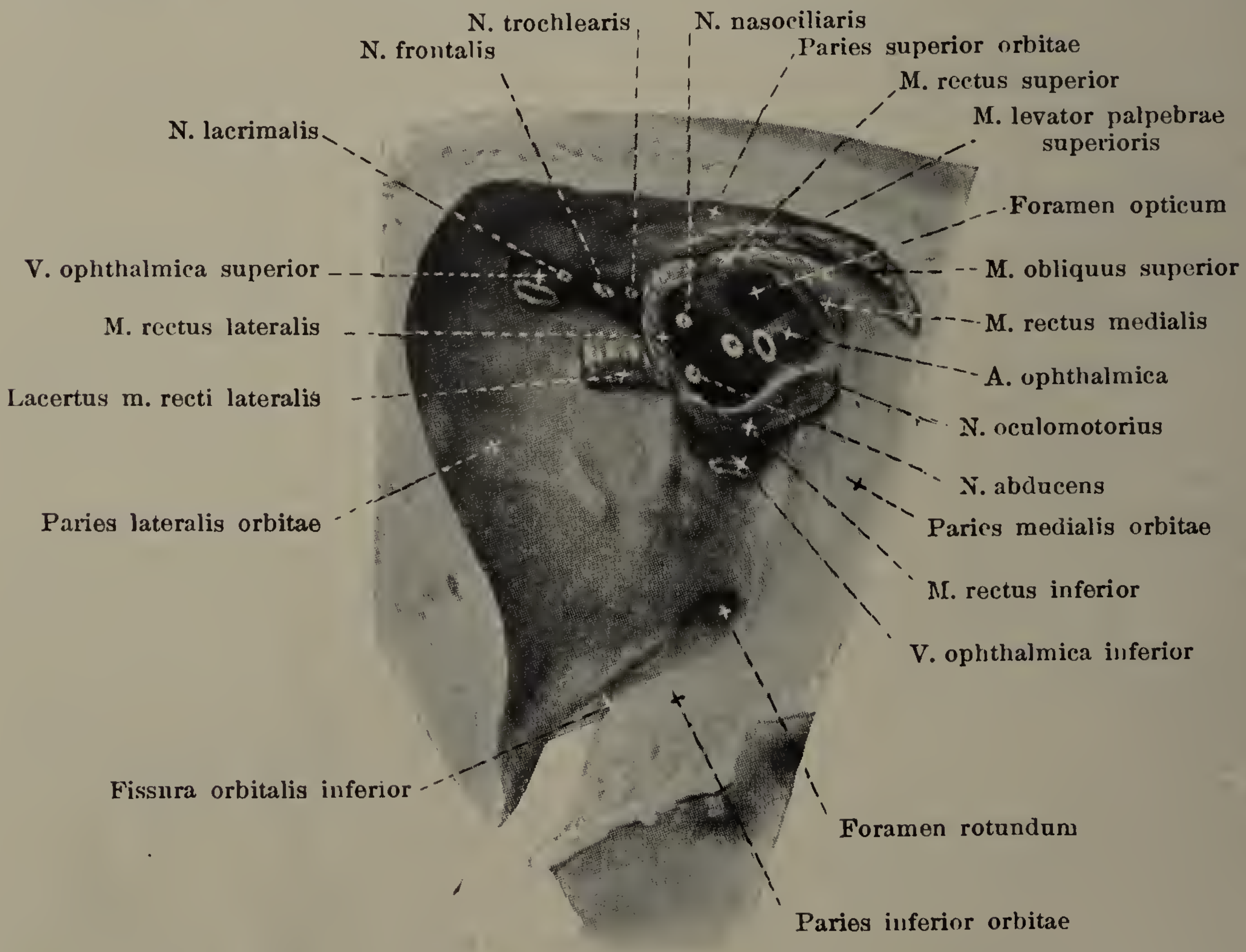
c) ***M. rectus inferior.*** Position: on the inferior wall of the orbital cavity, separated from it in front by the m. obliquus inferior; it runs obliquely forward and lateralward and forms an angle of about 25° with the visual line directed straight forward. Insertion: on the average 6.6 mm from the margin of the cornea; the line of insertion is 10 mm long, usually curved so as to be markedly convex forward and symmetrical, always somewhat oblique. Action: it turns the anterior pole downward and medianward and rolls the upper pole lateralward. The influence of the depressing component is greatest on looking lateralward, that of the rolling on looking medianward. Innervation: n. oculomotorius.

d) ***M. rectus lateralis*** (O. T. external rectus), with two heads (see p. 810). Position: on the lateral wall of the orbital cavity; it passes obliquely forward and lateralward. Insertion: on the average 7 mm from the margin of the cornea; the line of insertion is 10 mm long, curved so as to be slightly convex forward, usually symmetrical. Action: it turns the anterior pole lateralward. Innervation: n. abducens.

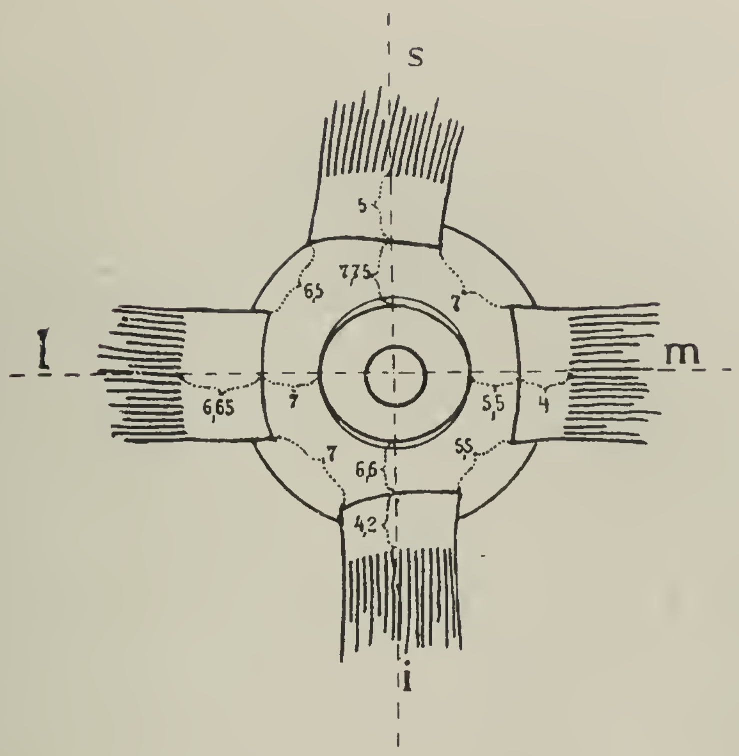
3. ***M. obliquus superior*** (see also Figs. 911—913, 915, 916, 918—922 and 924), the longest and thinnest eye-muscle. Origin: see p. 810. Insertion: It lies with its oblong rounded belly at the junction between the upper and medial walls of the orbit, directly on the bone, runs forward with its rounded tendon through a short fibrocartilaginous tube, *trochlea,* fastened to the fovea or spina trochlearis (here is a small bursa, ***bursa trochlearis)*** and bends at an angle of about 50° lateralward and backward through the fat to the bulbus; on this it passes on directly beneath the m. rectus superior and enters in a very variable manner behind the equator into the sclera by a tendon about 10 mm broad; its line of insertion is curved so as to be convex behind and lateralward, lies asymmetrically and obliquely (see Fig. 918) and is distant from the posterior end of the external axis of the eye by about 8 mm. Action: it turns the anterior pole downward and lateralward and rolls the upper pole medianward. The more the eye is directed medianward, the greater is the influence of the depressing component, the less that of the rolling. Innervation: n. trochlearis.



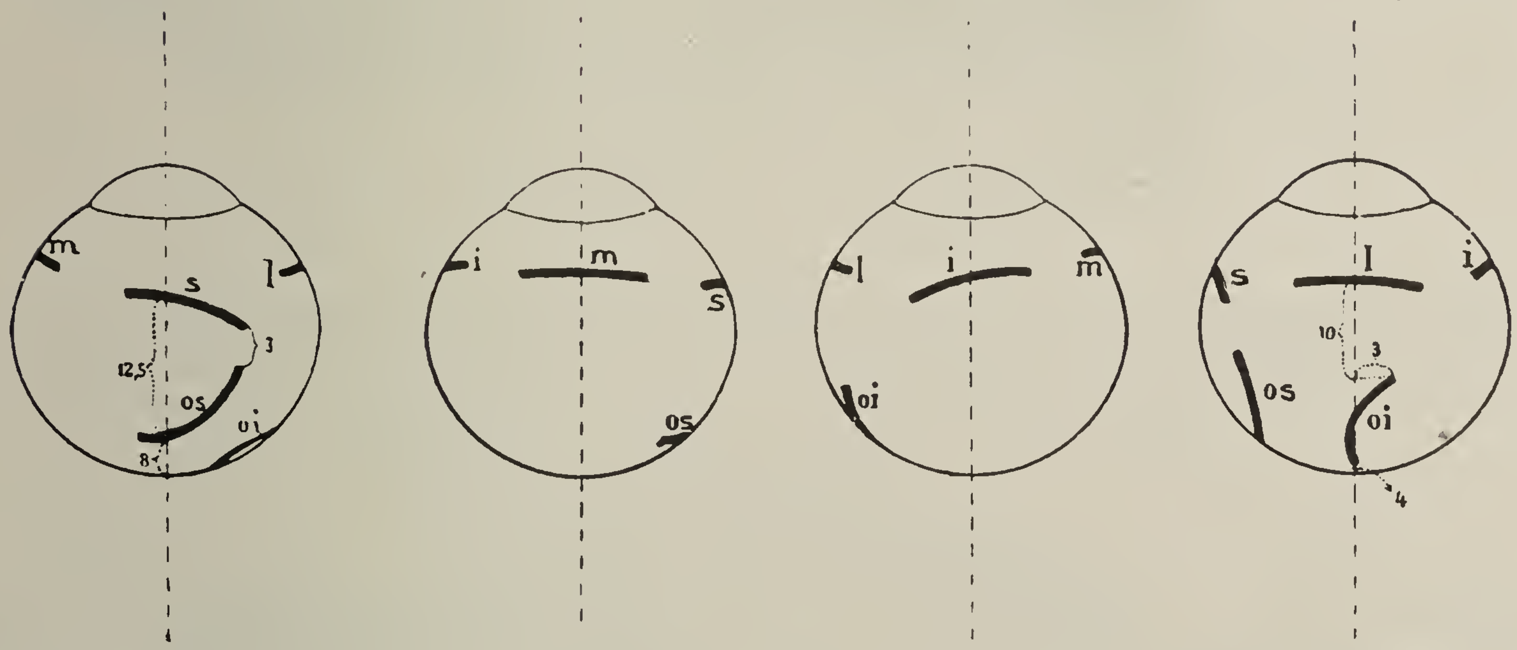
915. Back part of the right orbital cavity, viewed from in front and above. Magnification: 5:2.
(The fissura orbitalis superior and the foramen opticum have been opened from above.)



916. Origins of the muscles of the right orbital cavity, viewed from in front. Magnification: 3:2.
(The muscles, vessels and nerves have been cut off short.)



917. Insertions of the muscles on the right eyeball,
viewed from in front.
(The muscles have been pulled off from the eyeball.)



918. Insertions of the muscles on the right eyeball,

viewed from above.

viewed from the medial side.

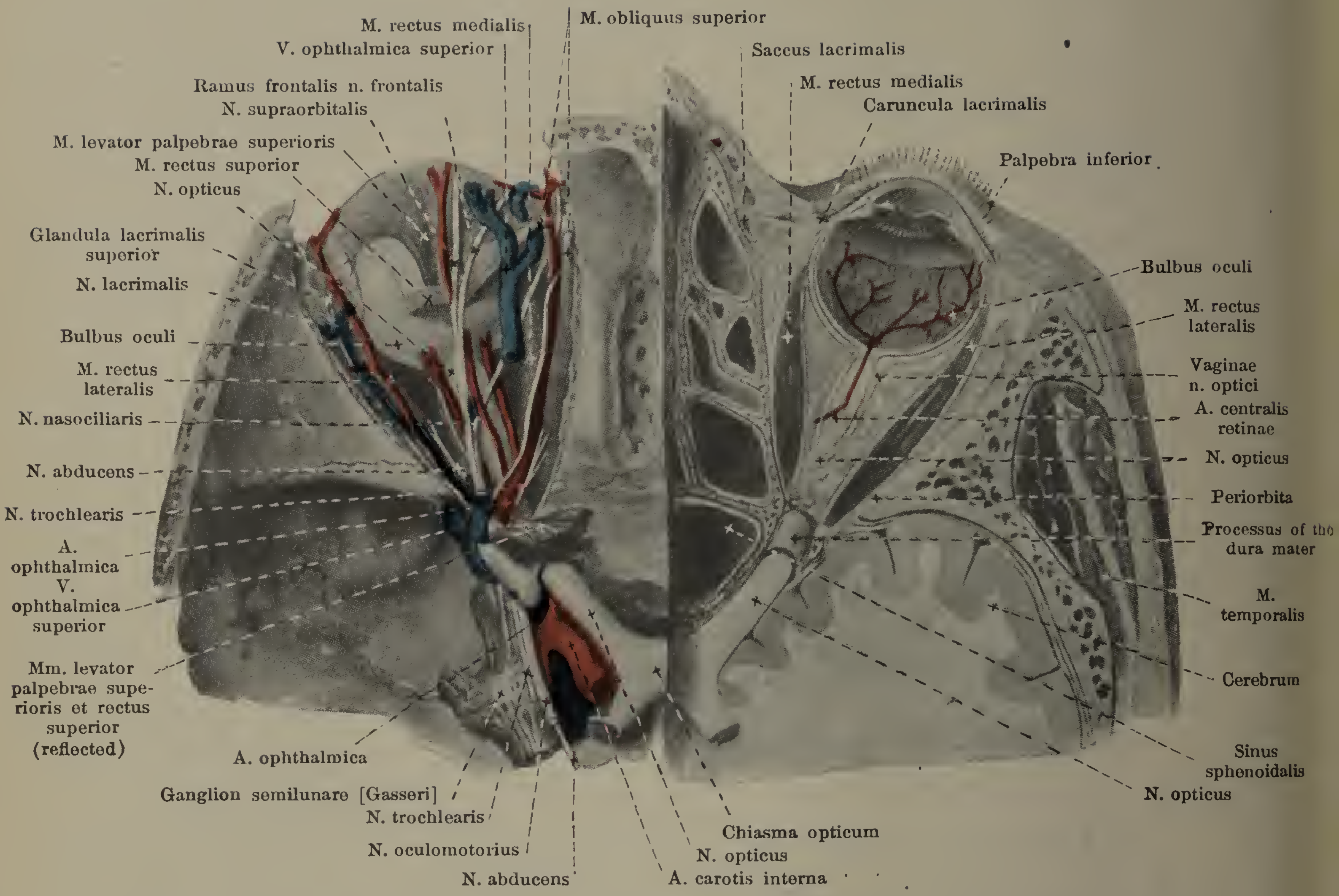
viewed from below.

viewed from the lateral side.

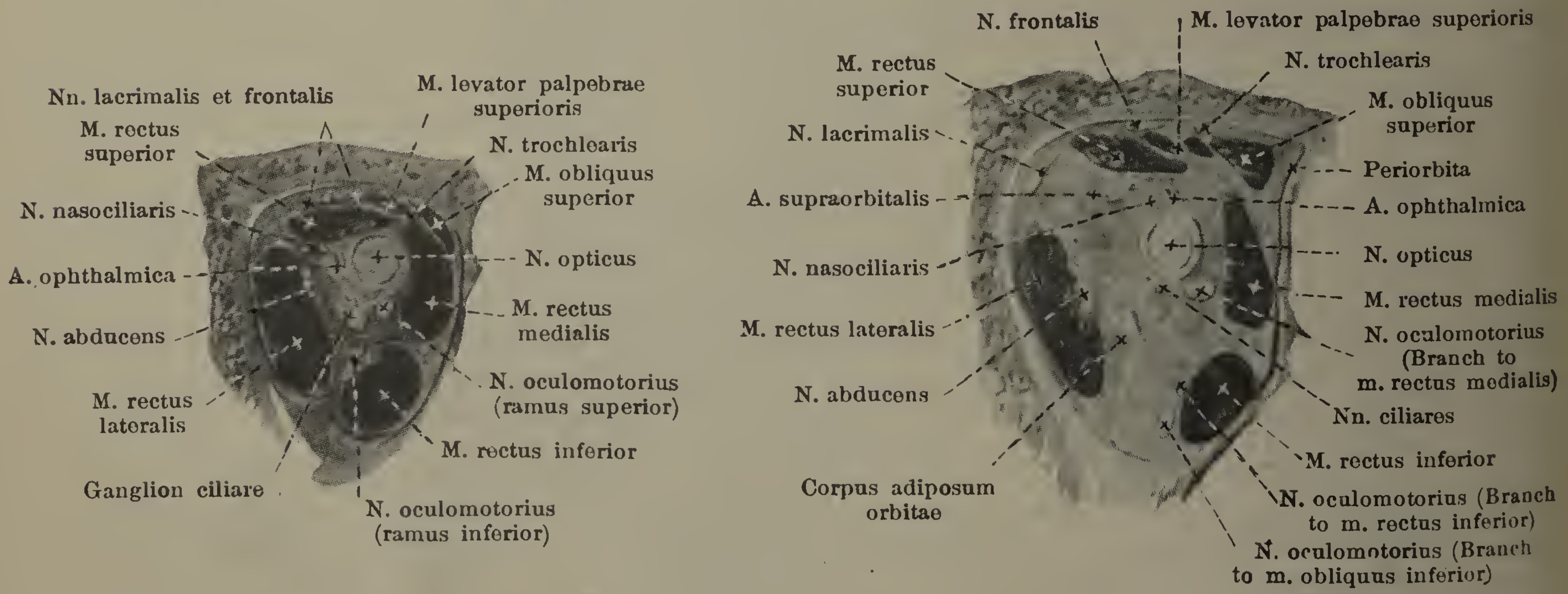
The Figs. 917 and 918 have been constructed from measurements made by H. Sattler.

The figures indicate millimeters; s = m. rectus superior, m = m. rectus medialis, i = m. rectus inferior, l = m. rectus lateralis, os = obliquus superior, oi = m. obliquus inferior.

4. *M. obliquus inferior* (see also Figs. 913, 914, 923, 924 and 932), the shortest eye muscle, arises from the anterior part of the inferior wall of the orbit, just lateral from the beginning of the canalis nasolacrimalis, passes through the fat, lateralward, upward and backward, beneath the m. rectus inferior, to the posterior half of the eyeball forming an angle of about 50° with the visual line directed straight forward and enters the sclera in a very variable manner by a tendon about 10 mm broad at the horizontal meridian; the line of insertion is curved so as to be slightly convex upward and is distant at its medial end by about 4 mm from the external axis of the eye. Action: it turns the anterior pole upward and lateralward and rolls the upper pole lateralward. The influence of the elevating component is greatest on looking medianward, that of the rolling on looking lateralward. Innervation: n. oculomotorius.

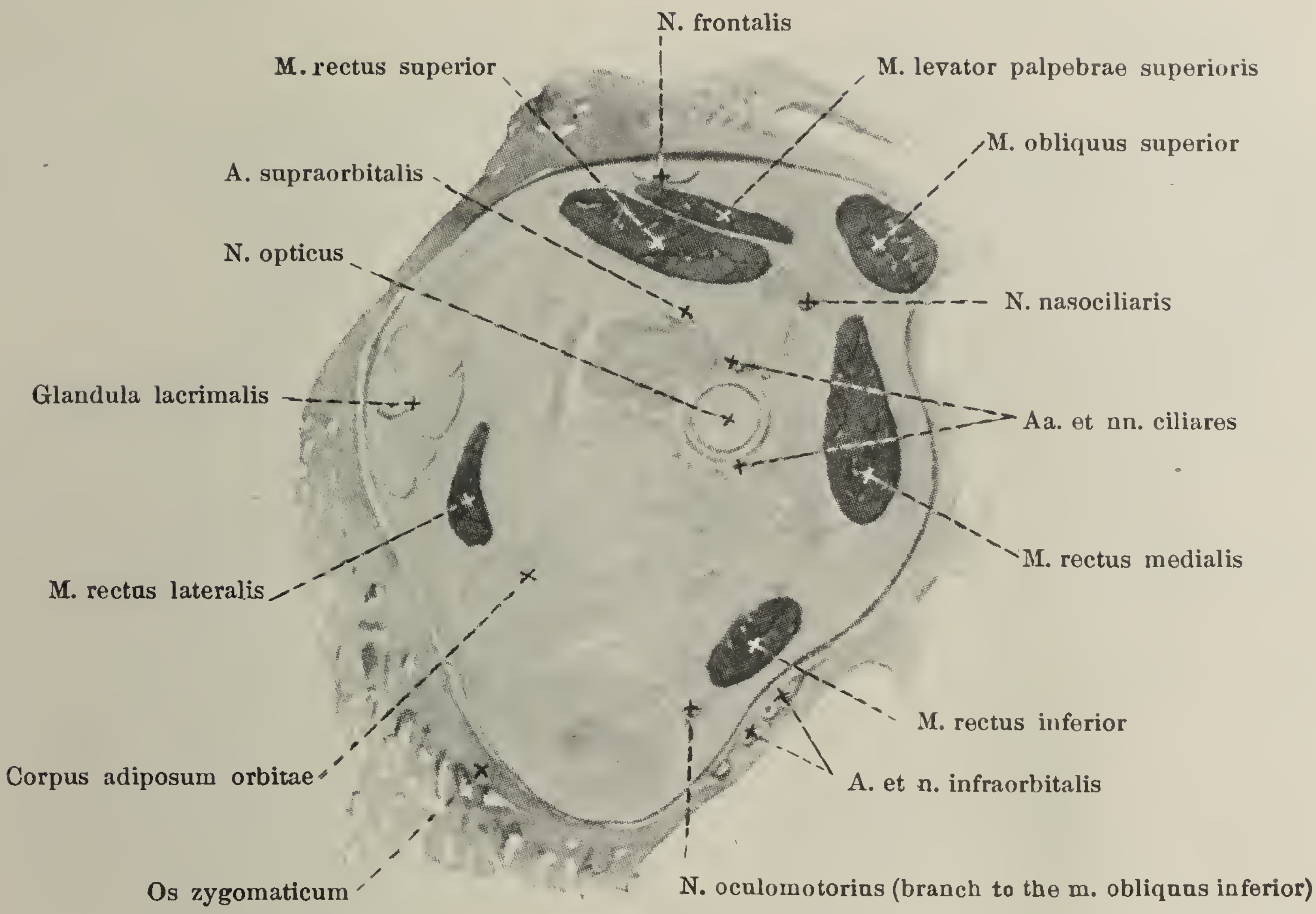


919. Contents of the orbital cavities, viewed from above (after H. Sattler). (On the left side the mm. levator palpebrae superioris and rectus superior have been partly removed and the vessels and nerves dissected out; on the right a horizontal section has been made at a somewhat deeper level.)

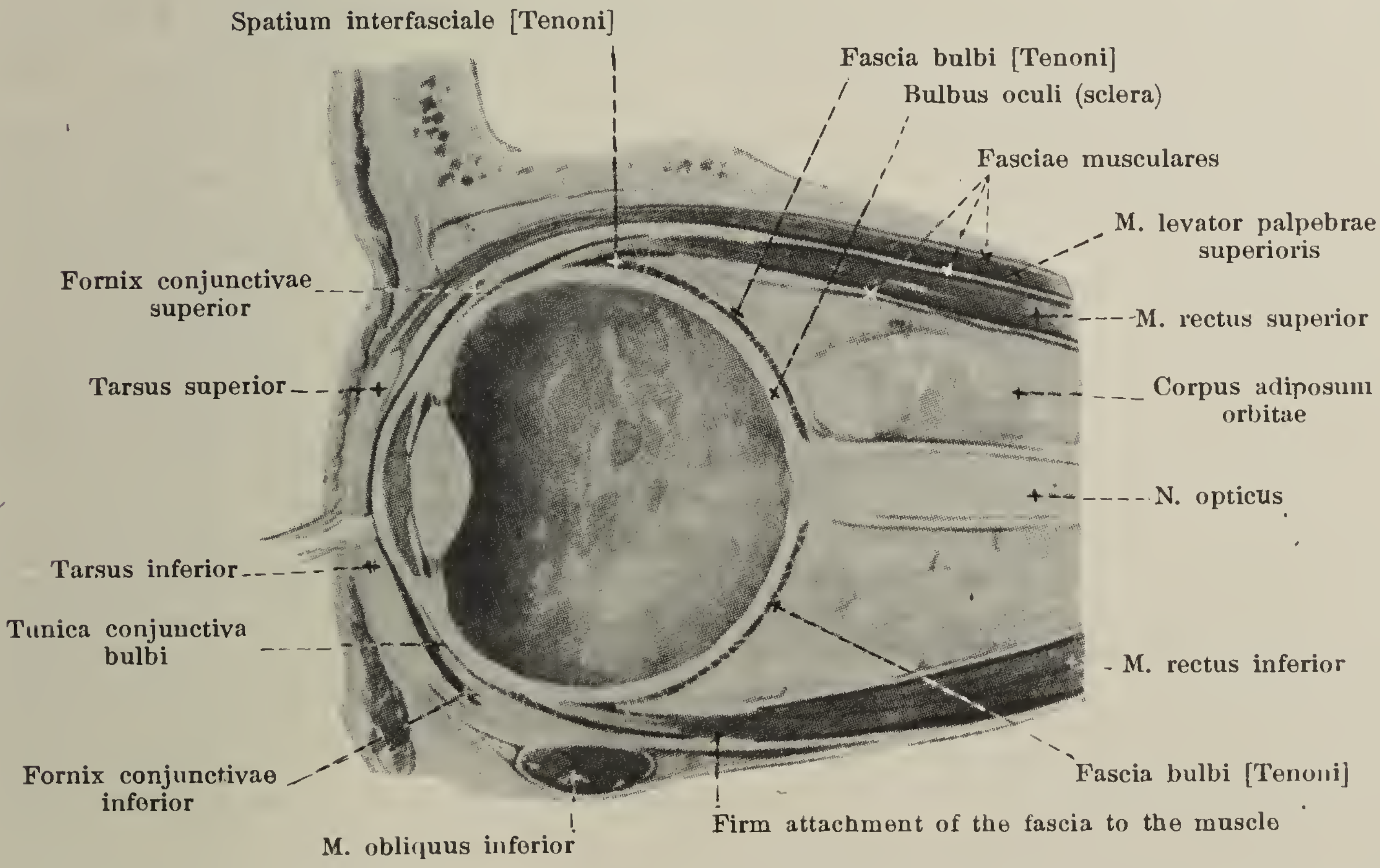


920 and 921. Frontal sections through the right orbital cavity, viewed from in front. Magnification: 3:2.

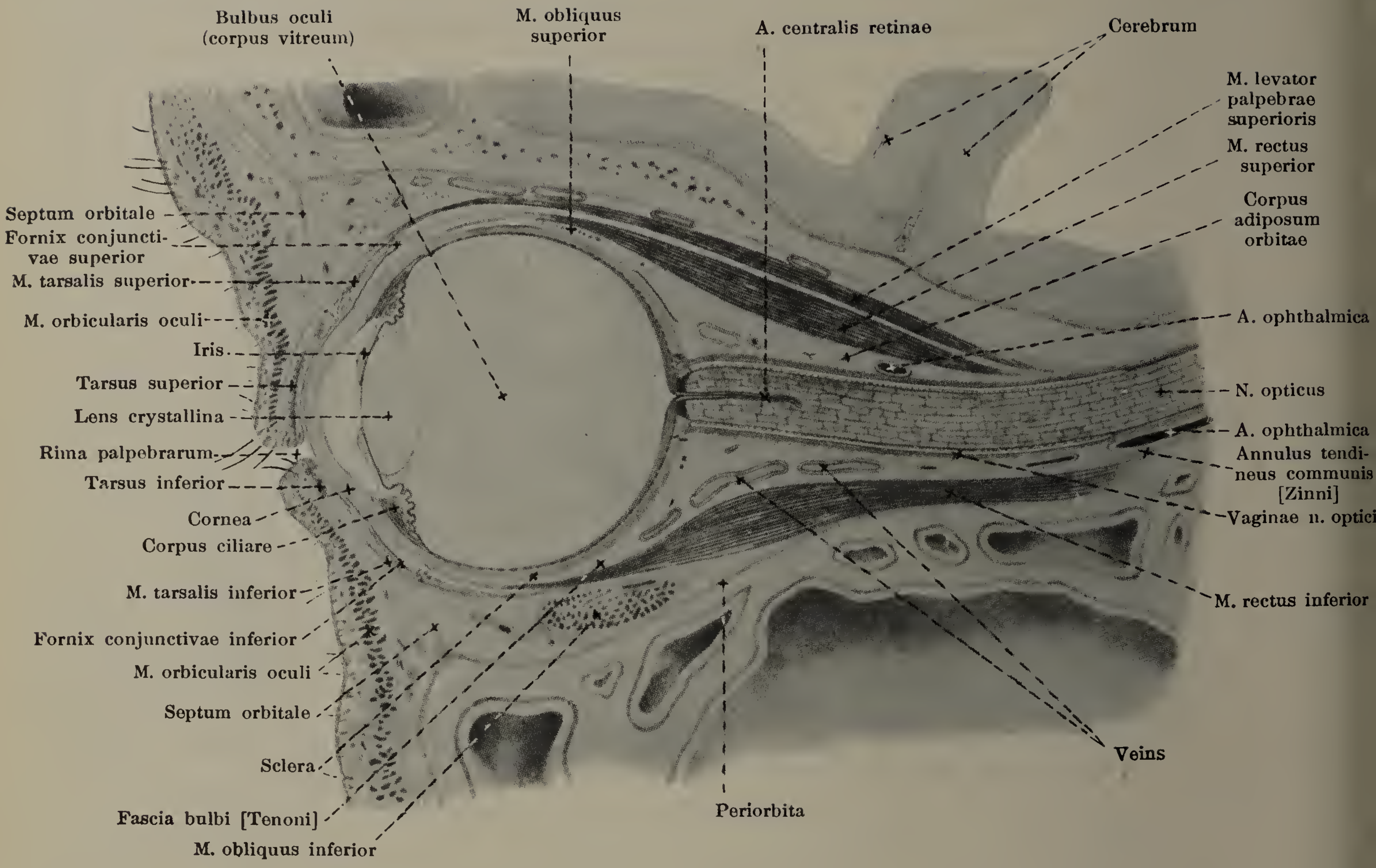
Close in front of the foramen opticum. Midway between foramen opticum and bulbus.



922. Frontal section through the right orbital cavity, viewed from in front close behind the bulbus. Magnification: 3 : 2.



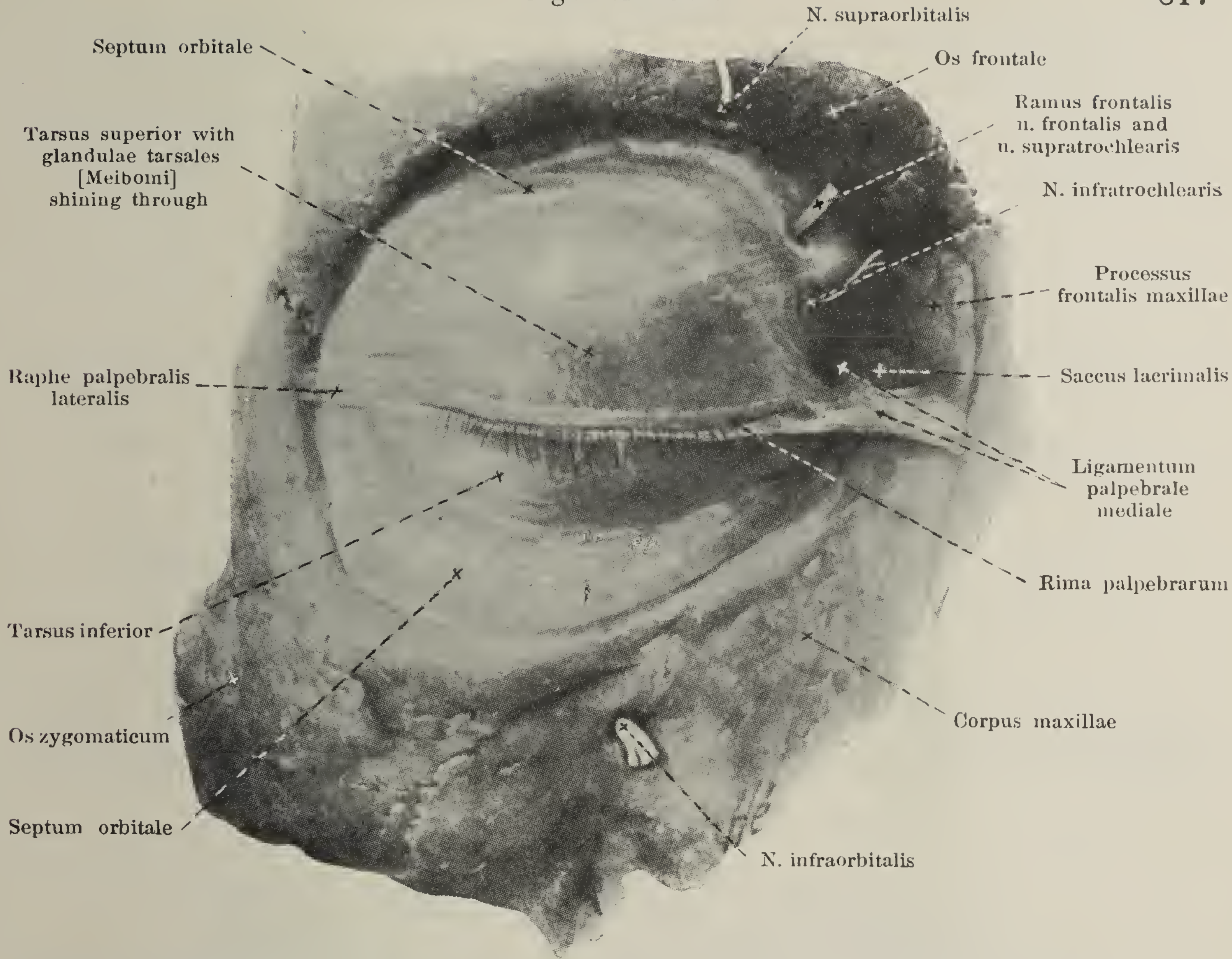
923. Vertical section through the eyeball, somewhat schematic (with use of a figure by H. Virchow). Magnification: 7 : 5.



924. Vertical section through the orbital cavity,
in the direction of the n. opticus (after H. Sattler). Magnification: 8:5.

Fasciae orbitales, fascias of the orbital cavity (see also Figs. 911, 913, 914, 919—923 and 925). The eyeball, with the exception of the corneal portion, is directly ensheathed by a connective tissue membrane, *fascia bulbi [Tenoni] (Tenon's capsule),* which in turn is again directly connected with the surrounding fat. This capsule has a lamellar structure and is relatively firm and of somewhat variable thickness. It is united everywhere with the sclera and the tendons of the eye-muscles (vide infra) by delicate reticular tissue, the communicating meshes of which are spoken of as the *spatium interfasciale [Tenoni] (Tenon's space).* The capsule is continuous in front with the conjunctiva bulbi and conjunctiva palpebrarum, behind it ends, very much thinned, at the point of entrance of the optic nerve (a little removed from it laterally). The tendons of the eye-muscles pass through slits in the capsule to the bulbus. Each eye-muscle is surrounded in the anterior half by a fascia, *fascia muscularis,* which becomes gradually thicker passing forward and which appears as a tube-like process of the fascia bulbi; this fascia ensheaths in front a continuation of Tenon's space, and somewhat behind the point of passage of the tendon through the fascia bulbi, is firmly united with the muscle (see Fig. 923). Tenon's capsule is attached in front by expanding bands laterally to the lateral orbital wall, medially to the fascia situated behind the pars lacrimalis m. orbicularis oculi and besides near the tendon of the m. obliquus superior to its trochlea. Tenon's space projects in front as far as beneath the conjunctiva bulbi.

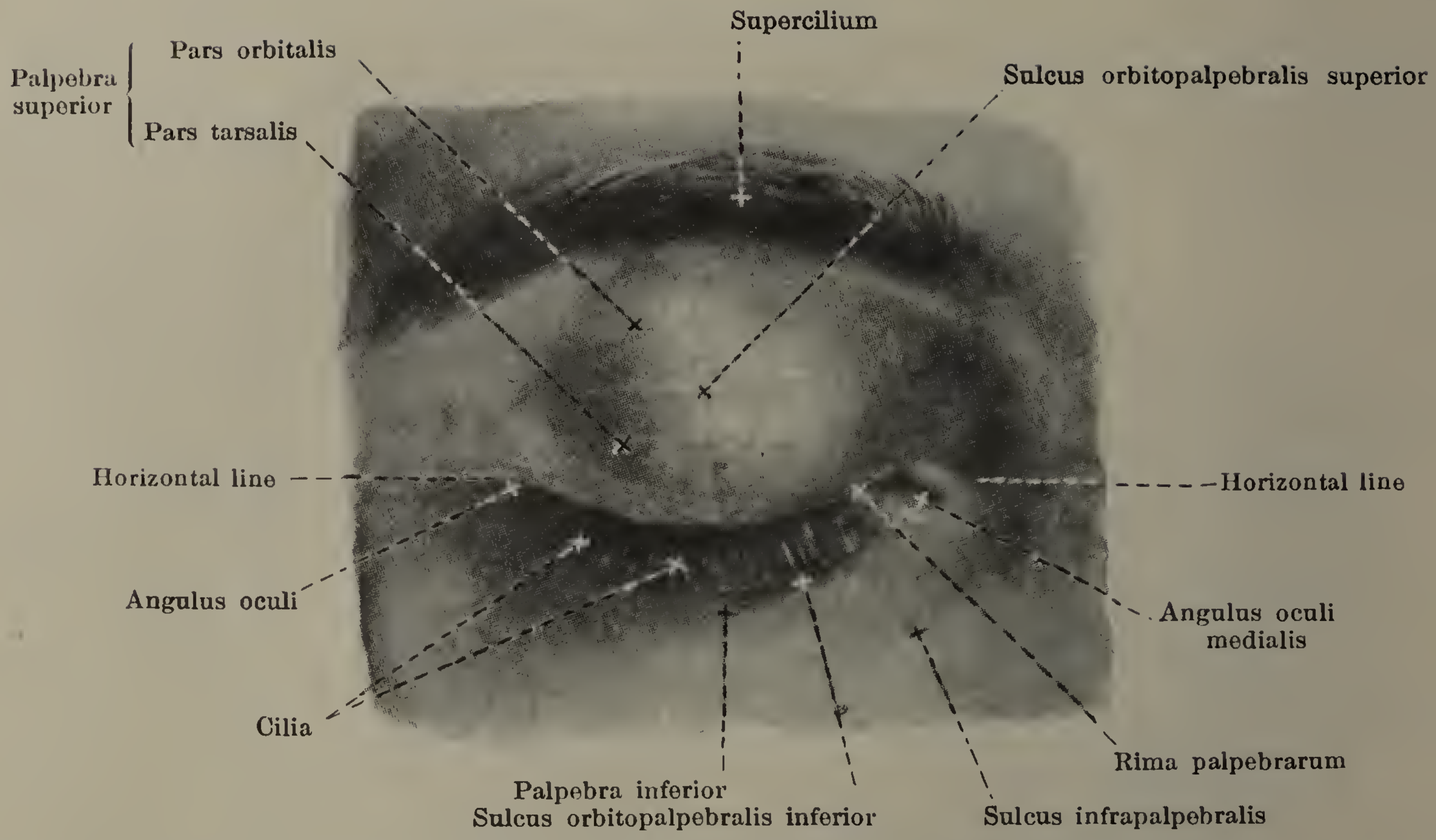
The orbital cavity is lined by a tolerably thin periosteum known as the *periorbita;* this is connected behind with the dural sheath of the n. opticus (see p. 795), partly closes the fissurae orbitales and goes over in front into the periosteum of the bones of the face; in the fissura orbitalis inferior it contains the thin (not illustrated) *m. orbitalis,* innervated by the sympathicus, consisting of smooth muscle fibres and also similar isolated bundles in other places. The space between the eyeball, the optic nerve, the muscles and the lachrymal glands is filled up by fatty connective tissue, *corpus adiposum orbitae, fat body of the orbital cavity,* through which the vessels and nerves run.


N. supraorbitalis
Septum orbitale
Os frontale
Ramus frontalis n. frontalis and n. supratrochlearis
Tarsus superior with glandulae tarsales [Meibomi] shining through
N. infratrochlearis
Processus frontalis maxillae
Raphe palpebralis lateralis
Saccus lacrimalis
Ligamentum palpebrale mediale
Rima palpebrarum
Tarsus inferior
Corpus maxillae
Os zygomaticum
Septum orbitale
N. infraorbitalis

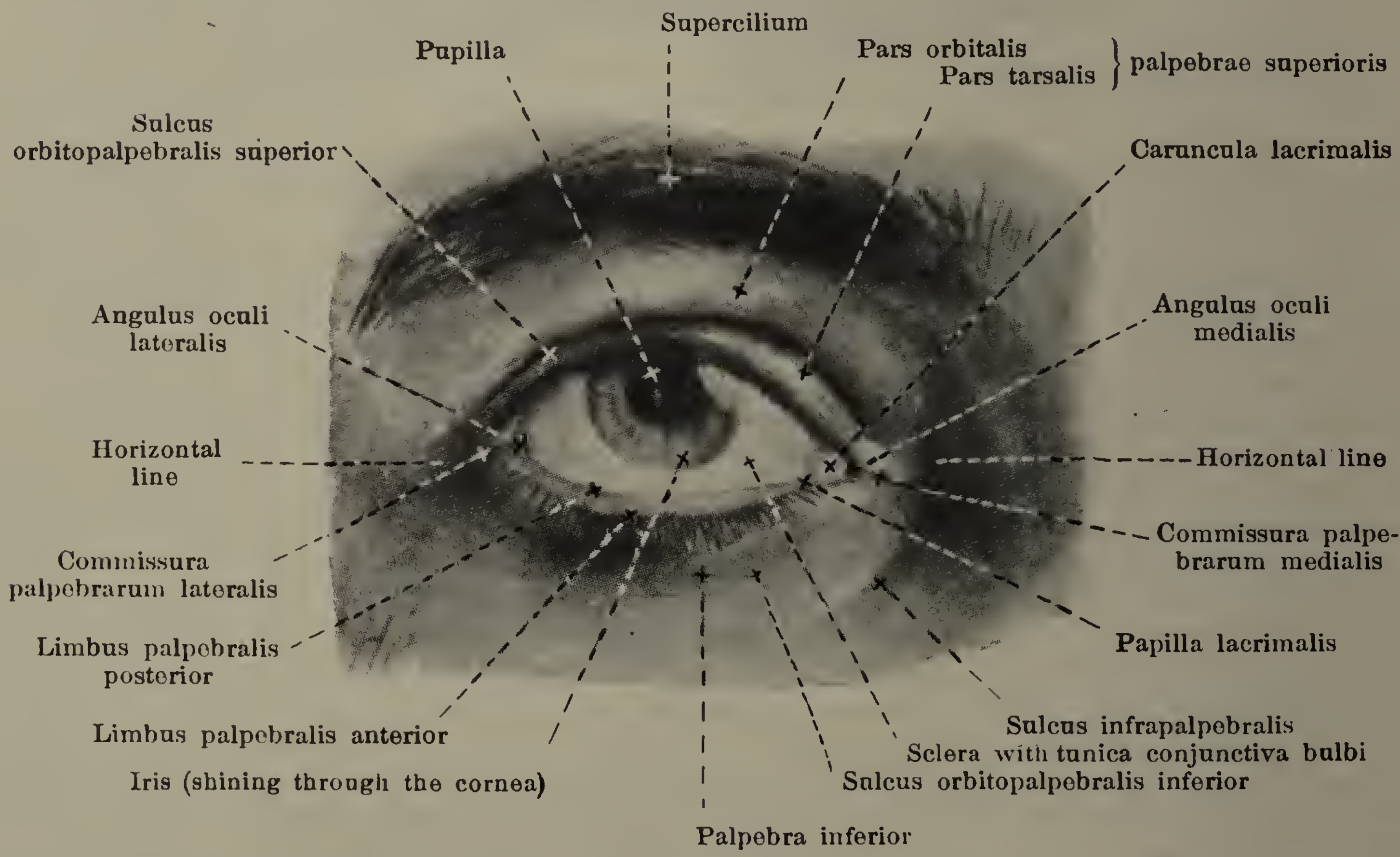
925. Right septum orbitale, viewed from in front. Magn.: 4:3.
(The m. orbicularis oculi has been dissected off.)

The orbital cavity is bounded in front toward the eyelids by a layer of fascia, *septum orbitale* (see also Figs. 924 and 930), which is fastened to the aditus orbitae and stretches out into the lids. In the upper lid it coincides with the anterior expansion of the m. levator palpebrae superioris and, united with it, passes downward behind the m. orbicularis oculi, being intimately united with the anterior surface of the tarsus; in the lower lid it runs isolated in a corresponding way. The septum therefore lies in front of the conjunctival sack. Above it arises from a narrow tough marginal strip of connective tissue fastened to the margo supraorbitalis which transforms the incisurae supraorbitalis and frontalis into canals; medianward its attachment lies behind the crista lacrimalis posterior (therefore also behind the pars lacrimalis m. orbicularis oculi). The septum is not everywhere of the same thickness, being most powerfully developed at the upper circumference while at the lower it is very delicate and sometimes perforated by fat lobules; it is also very thin upon the tarsi; laterally it is strengthened by the *raphe palpebralis lateralis* (see p. 261).

***Palpebrae,** eyelids* (see Figs. 923, 924 and 926—931), are two folds of the external skin, which are shoved in front of the anterior surface of the eyeball until they touch with their free margins, one from above, *palpebra superior,* and one from below, *palpebra inferior.* The upper eyelid is somewhat larger than the lower. The boundary of the upper eyelid above is to be seen in the *eyebrow, supercilium;* this is a ridge, convex upward, running at the level of the margo supraorbitalis; it is thickly studded with stiff hairs directed in general lateralward; the position and size of the eyebrows varies greatly, and so does the color. The lower eyelid is indistinctly bounded below by a gutter-like groove, *sulcus infrapalpebralis,* which begins medial from the inner angle of the eye, passes lateralward and downward and ends somewhat above the level of the margo infraorbitalis; in old age the groove becomes deeper and there are added to it other furrows especially at the lateral angle of the eye. The free margins of the eyelids which bound the *lid-slit, rima palpebrarum,* have each an anterior and a posterior, sharp or (especially in front) slightly blunted edge, *limbus palpebralis anterior* and *posterior;* at the lateral and medial ends of the lid-slit they go over into one another at the *commissura palpebrarum lateralis* and *medialis* and with these bound the lateral and medial *angles of the eye, angulus oculi lateralis* and *medialis.*



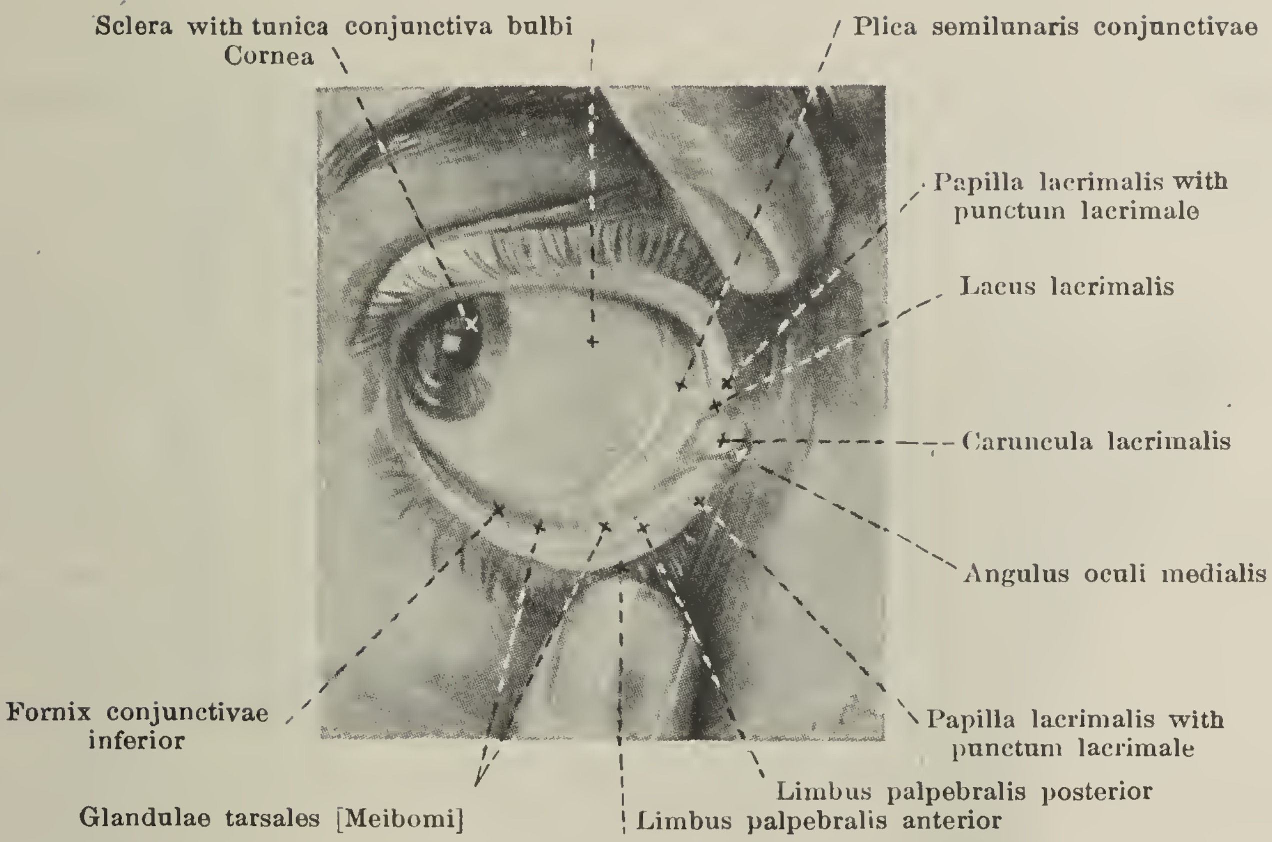
926. Right eye, closed, of a twenty-year old girl, viewed from in front.


Supercilium
Papilla
Pars orbitalis
Pars tarsalis
palpebrae superioris
Sulcus orbitopalpebralis superior
Caruncula lacrimalis
Angulus oculi lateralis
Angulus oculi medialis
Horizontal line
Horizontal line
Commissura palpebrarum lateralis
Commissura palpebrarum medialis
Limbus palpebralis posterior
Papilla lacrimalis
Limbus palpebralis anterior
Sulcus infrapalpebralis
Sclera with tunica conjunctiva bulbi
Iris (shining through the cornea)
Sulcus orbitopalpebralis inferior
Palpebra inferior

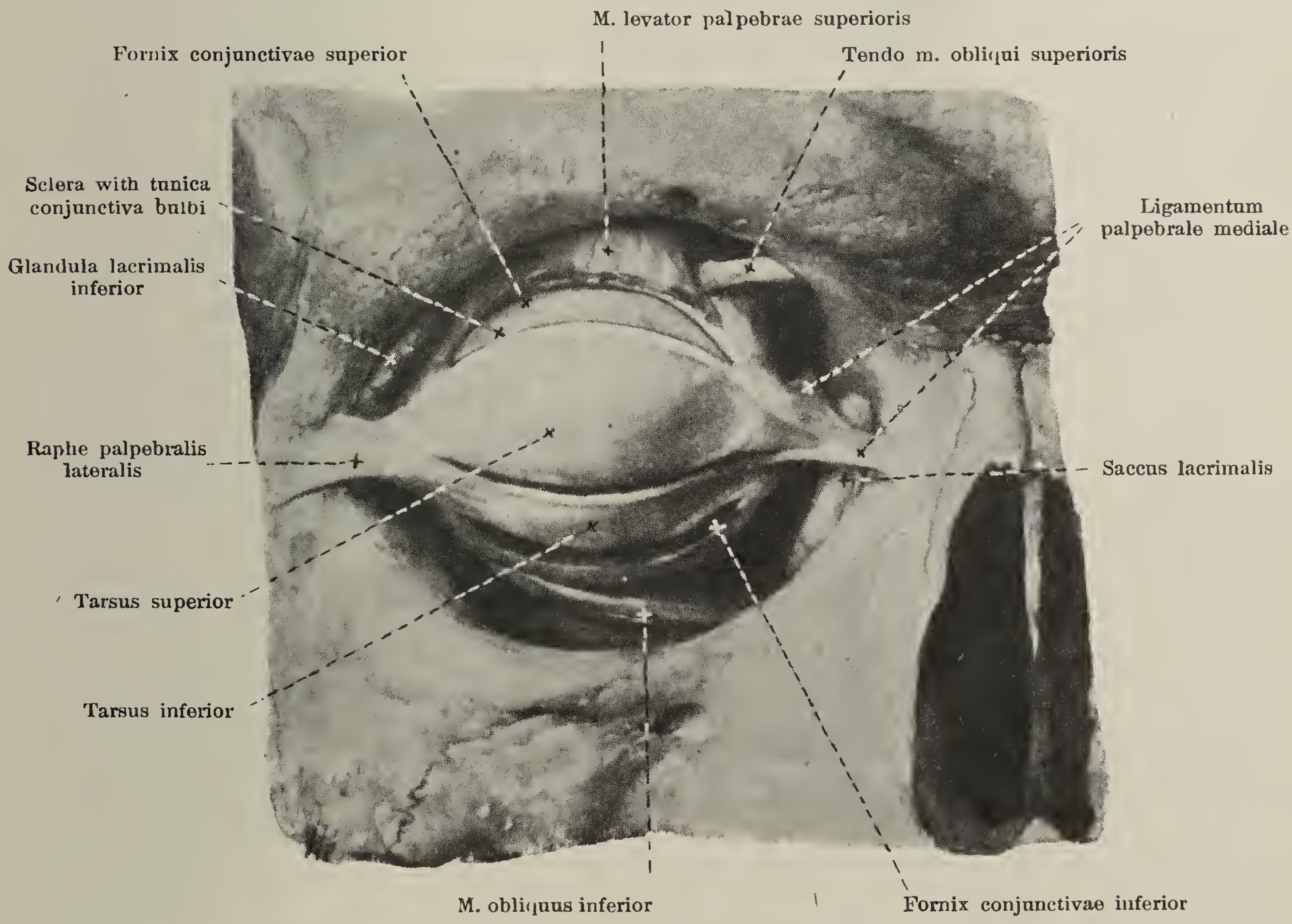
927. Right eye, open, of a twenty-year old girl, viewed from in front.

(The horizontal lines in Figs. 926 and 927 correspond to one another.)

Palpebrae (continued) (see also Figs. 923, 924 and 928—932). The *angulus oculi lateralis* is acute; the *angulus oculi medialis* is situated somewhat deeper, is a rounded evagination of the lid-slit and surrounds the *lachrymal lake, lacus lacrimalis.* When the lids are open, a small club-shaped elevation of the conjunctiva, *caruncula lacrimalis,* is visible and lateral from it a sickle-shaped fold of the mucous membrane, *plica semilunaris conjunctivae,* concave lateralward, passes from the fornix superior to the fornix inferior of the conjunctiva. The lachrymal lake reaches laterally as far as a small cone-shaped elevation of each eyelid, *papilla lacrimalis,* upon the apex of which directed somewhat backward, the lachrymal tubule begins as a punctate opening, the *punctum lacrimale,* somewhat larger in the lower lid than in the upper.


Sclera with tunica conjunctiva bulbi
Cornea
Plica semilunaris conjunctivae
Papilla lacrimalis with punctum lacrimale
Lacus lacrimalis
Caruncula lacrimalis
Angulus oculi medialis
Fornix conjunctivae inferior
Papilla lacrimalis with punctum lacrimale
Limbus palpebralis posterior
Glandulae tarsales [Meibomi]
Limbus palpebralis anterior

928. Right eye, with lids forcibly pulled apart, of a twenty-year old girl, viewed from in front. (The eyeball has been turned to the right.)

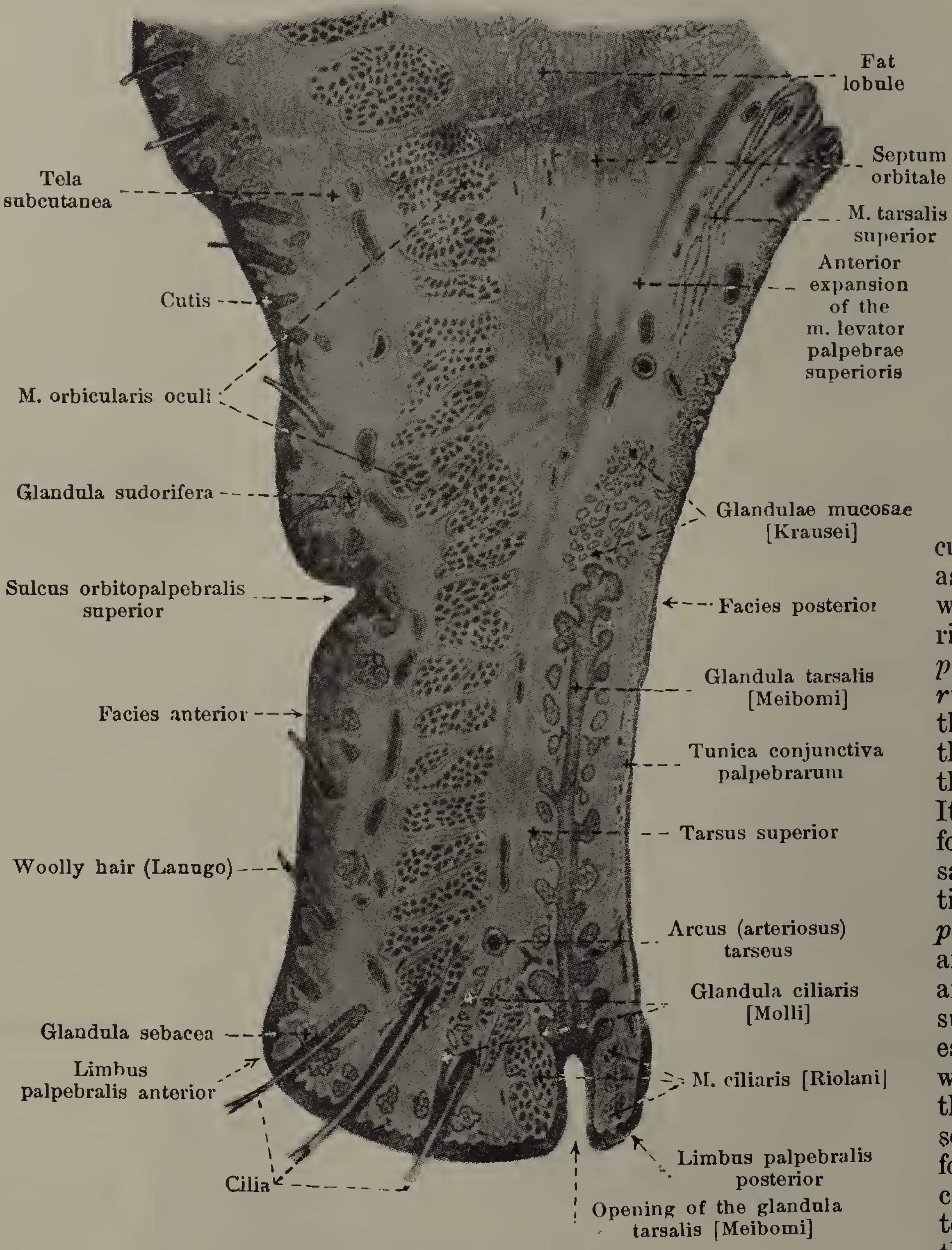

M. levator palpebrae superioris
Fornix conjunctivae superior
Tendo m. obliqui superioris
Sclera with tunica conjunctiva bulbi
Ligamentum palpebrale mediale
Glandula lacrimalis inferior
Raphe palpebralis lateralis
Saccus lacrimalis
Tarsus superior
Tarsus inferior
M. obliquus inferior
Fornix conjunctivae inferior

929. Lid-plates of the right eye, dissected out, viewed from in front. Magnification: 4:3.

(The lid-plates and the eye-muscles have been dissected out; the insertion of the m. levator palpebrae superioris has been removed, and the conjunctival sack has been opened from in front above and below the lid-plates.)

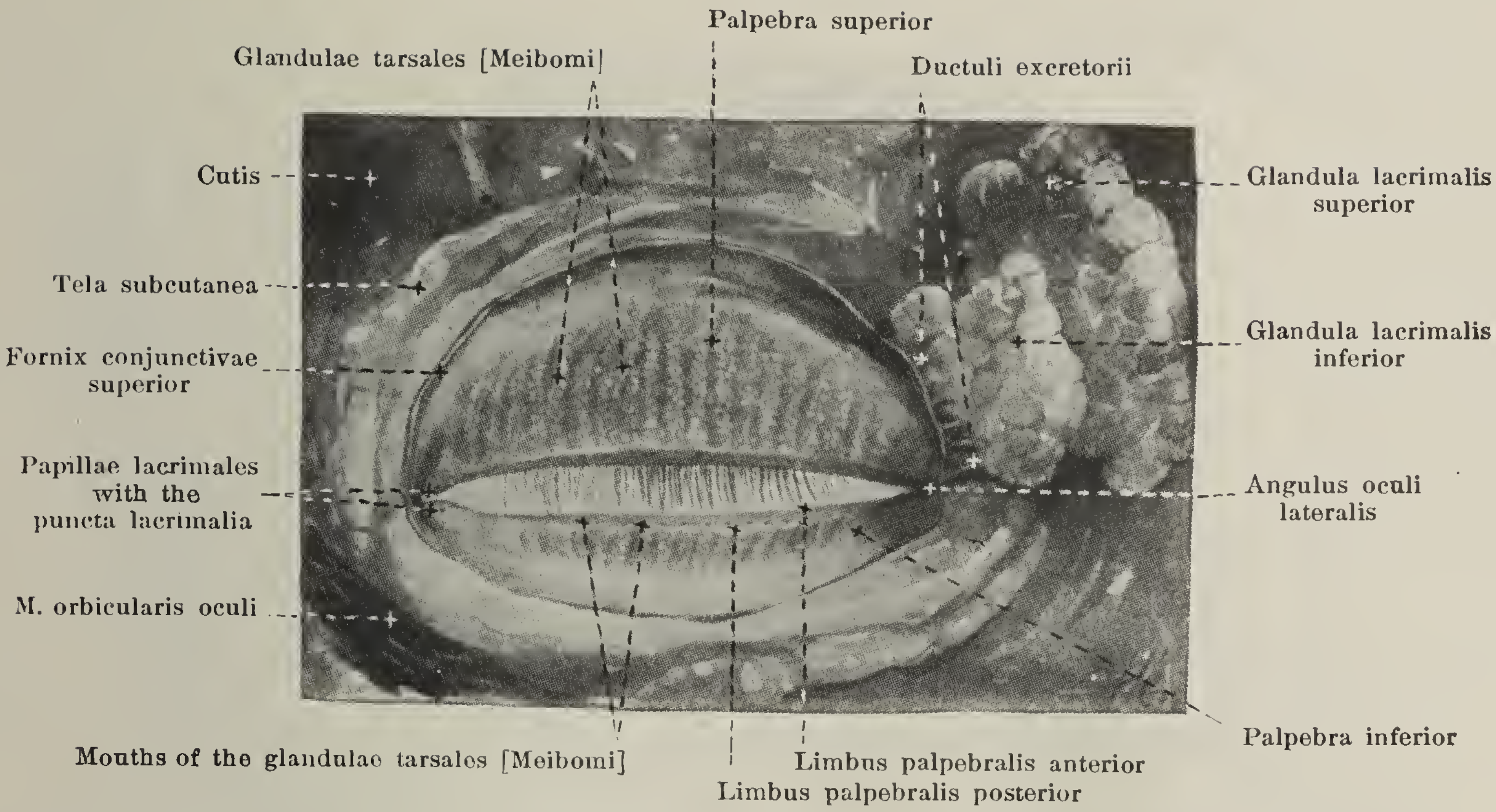
930. Cross-section through the upper eyelid

(after H. Sattler). Magnification: 14:1.


Fat lobule
Septum orbitale
M. tarsalis superior
Anterior expansion of the m. levator palpebrae superioris
Tela subcutanea
Cutis
M. orbicularis oculi
Glandula sudorifera
Glandulae mucosae [Krausei]
Sulcus orbitopalpebralis superior
Facies posterior
Glandula tarsalis [Meibomi]
Facies anterior
Tunica conjunctiva palpebrarum
Tarsus superior
Woolly hair (Lanugo)
Arcus (arteriosus) tarseus
Glandula ciliaris [Molli]
Glandula sebacea
Limbus palpebralis anterior
M. ciliaris [Riolani]
Limbus palpebralis posterior
Cilia
Opening of the glandula tarsalis [Meibomi]

Palpebrae (continued) (see also Figs. 923, 924, 928, 929 and 931): The *rima palpebrarum* when the lids are open is biconvex and presents marked individual variations. When the lids are closed, it is a curved slit, convex below, which passes below a horizontal line drawn through the two angles of the eye.

The eyelid is curved saucer-like so as to be convex forward, and on its posterior surface, *facies posterior palpebrarum,* is separated from the eyeball only by the slit-like space of the conjunctival sack. Its firm foundation is formed by two tough, saucer-like connective tissue discs, the *lid-plates, tarsus superior* and *inferior*, which are united with the surrounding tissue and especially intimately with the conjunctiva: these discs are curved so as to be convex forward and present a convex margin turned toward the insertion of the lid and a straight margin reaching to the lid-slit. At their medial, blunter angles, they are continuous with the lig. palpebrale mediale, at their lateral sharper angles, with the raphe palpebralis lateralis; the upper disc is twice as high as the lower. In the substance of the lid-plates lie the *glandulae tarsales [Meibomi],* in the upper lid 30—40, in the lower lid 20—30, usually closely crowded into a row, running approximately vertically through the whole height of the lid-plate (see also Fig. 931) and corresponding in their fine structure with the sebaceous glands; on account of their richness in fat they show through yellowish upon the back side of the lid; their excretory ducts end by punctate openings on the free margin near the limbus palpebralis posterior. Their secretion, ***sebum palpebrale,*** is rich in fat. To the upper margin of the tarsus superior is attached the posterior tendinous expansion of the m. levator palpebrae superioris and the *m. tarsalis superior* (see p. 810), to the lower margin of the tarsus inferior the *m. tarsalis inferior* (see Fig. 924), a bundle of smooth muscle fibres which passes out from the region of the fornix conjunctivae inferior.


Palpebra superior
Glandulae tarsales [Meibomi]
Ductuli excretorii
Cutis
Glandula lacrimalis superior
Tela subcutanea
Glandula lacrimalis inferior
Fornix conjunctivae superior
Papillae lacrimales with the puncta lacrimalia
Angulus oculi lateralis
M. orbicularis oculi
Palpebra inferior
Mouths of the glandulae tarsales [Meibomi]
Limbus palpebralis anterior
Limbus palpebralis posterior

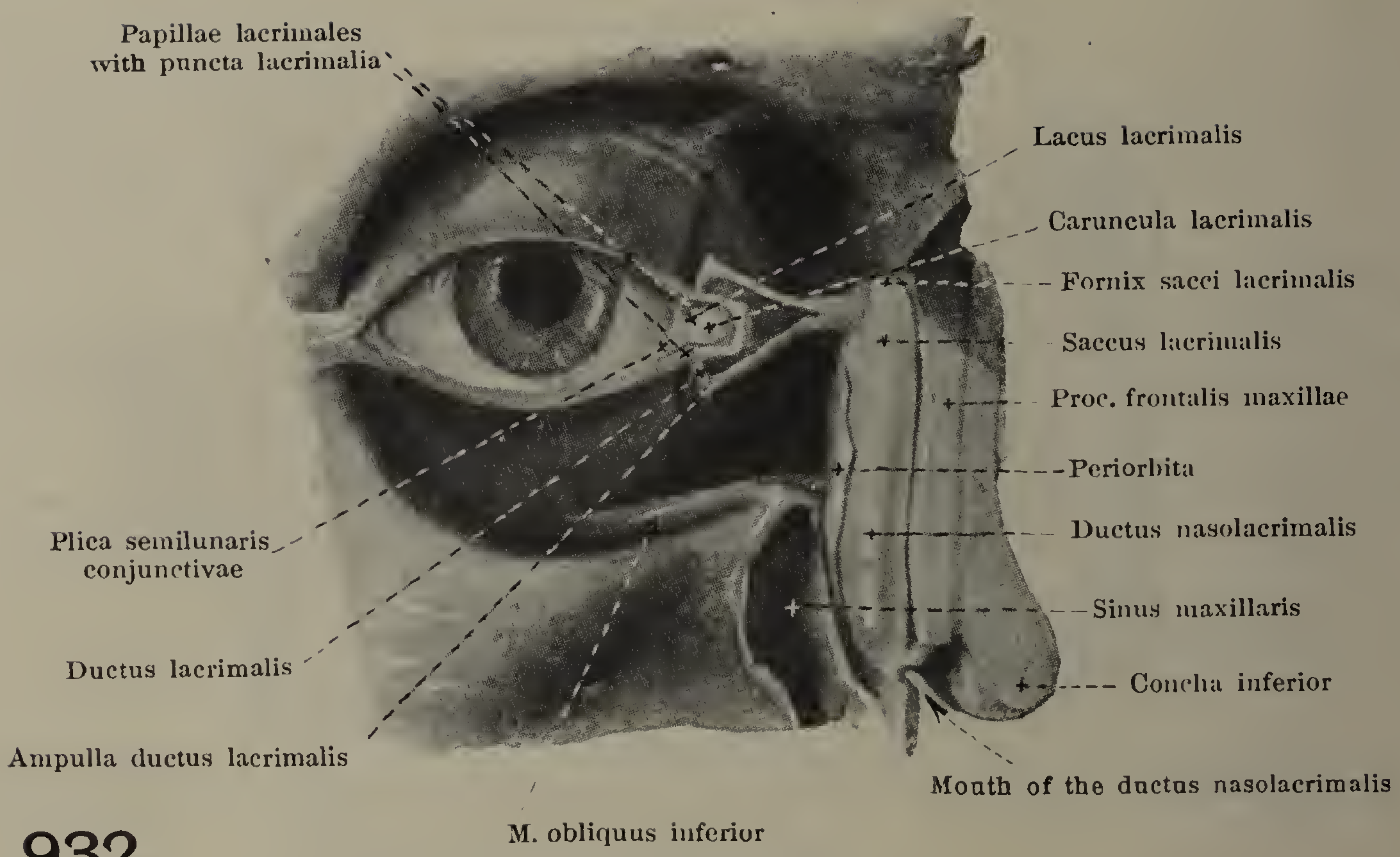
931. Lids of the right eye with the lachrymal glands,

viewed from behind.

(The lids have been loosened from the subjacent tissue; the muscle has been for the most part dissected off.)

Palpebrae (continued) (see also Figs. 923, 924 and 928—930). The anterior surface of the eyelids, *facies anterior palpebrarum*, is formed by the external skin which goes over at the free margin of the lid directly into the tunica conjunctiva palpebrarum; it is delicate and devoid of fat, and presents many fine, transverse wrinkles, in middle and advanced age also numerous vertical folds. In the region of the lidplate, *pars tarsalis palpebrae*, it is firmly united with the subjacent tissue, in the other part, *pars orbitalis palpebrae*, more loosely. The junction between these two portions is formed in the upper lid by the *sulcus orbitopalpebralis superior* (see Figs. 926 and 927), a curve which is deep when the lid-slit is open and above which the pars orbitalis projects as *superior palpebral fold*, and to which the tendon fibres of the m. levator palpebrae superioris are attached; in the lower eyelid a feeble corresponding furrow, *sulcus orbitopalpebralis inferior*, is visible in the medial half only (see Figs. 926 and 927), when the m. orbicularis oculi is contracted highly. Beneath the loose subcutaneous connective tissue the m. orbicularis oculi spreads out (see p. 261), bundles of which directly adjacent to the lid-slit *(m. ciliaris [Riolani]*, see Fig. 930) run between the excretory ducts of the glandulae tarsales, the hair follicles of the eyelashes and the glandulae ciliares [Molli]. The *eyelashes, cilia*, appear on the free margin of the lid and behind the limbus palpebralis anterior; they are arranged generally in three rows and stand closely together and are more numerous (100—150) in the upper lid than they are in the lower (50—75); they are stiff, directed obliquely downward in the upper lid, obliquely upward in the lower lid, and so curved that the convexity of the upper is turned toward that of the lower. The eyelashes possess *glandulae sebaceae, sebaceous glands*, like other hairs and usually receive the mouths of the *glandulae ciliares [Molli]*, modified sweat glands (see Fig. 930). The posterior surface of the lid is covered by the *tunica conjunctiva palpebrarum* (vide infra).

Conjunctiva*, connecting membrane* (see also Figs. 893, 895, 913, 923, 924 and 927—930), is a mucous-membrane-like continuation of the external skin which lines the posterior surface of the lids as the *tunica conjunctiva palpebrarum*, then, forming the upper and lower transition folds, *fornix conjunctivae superior* and *inferior*, it passes over upon the anterior surface of the sclera and extends on in front of the latter as the *tunica conjunctiva bulbi* (see pp. 797 and 798) as far as the cornea; thus when the lids are closed it forms a closed sack, the *conjunctival sack*, the anterior wall of which is formed by the lids and the posterior wall by the eyeball (see also p. 818). The tunica conjunctiva palpebrarum upon the tarsus is firmly united with the subjacent tissue and studded with minute depressions; above the tarsus it is more loosely attached and when the lid is open, presents coarse, concentric folds. Small mucous glands, *glandulae mucosae [Krausei]*, which are looked upon as accessory lachrymal glands, occur on the fornix conjunctivae and in the upper margin of the tarsus superior. Some lymph-nodes, *noduli lymphatici conjunctivales*, not always distinctly defined, are also present in the fornix and its neighborhood under normal conditions.

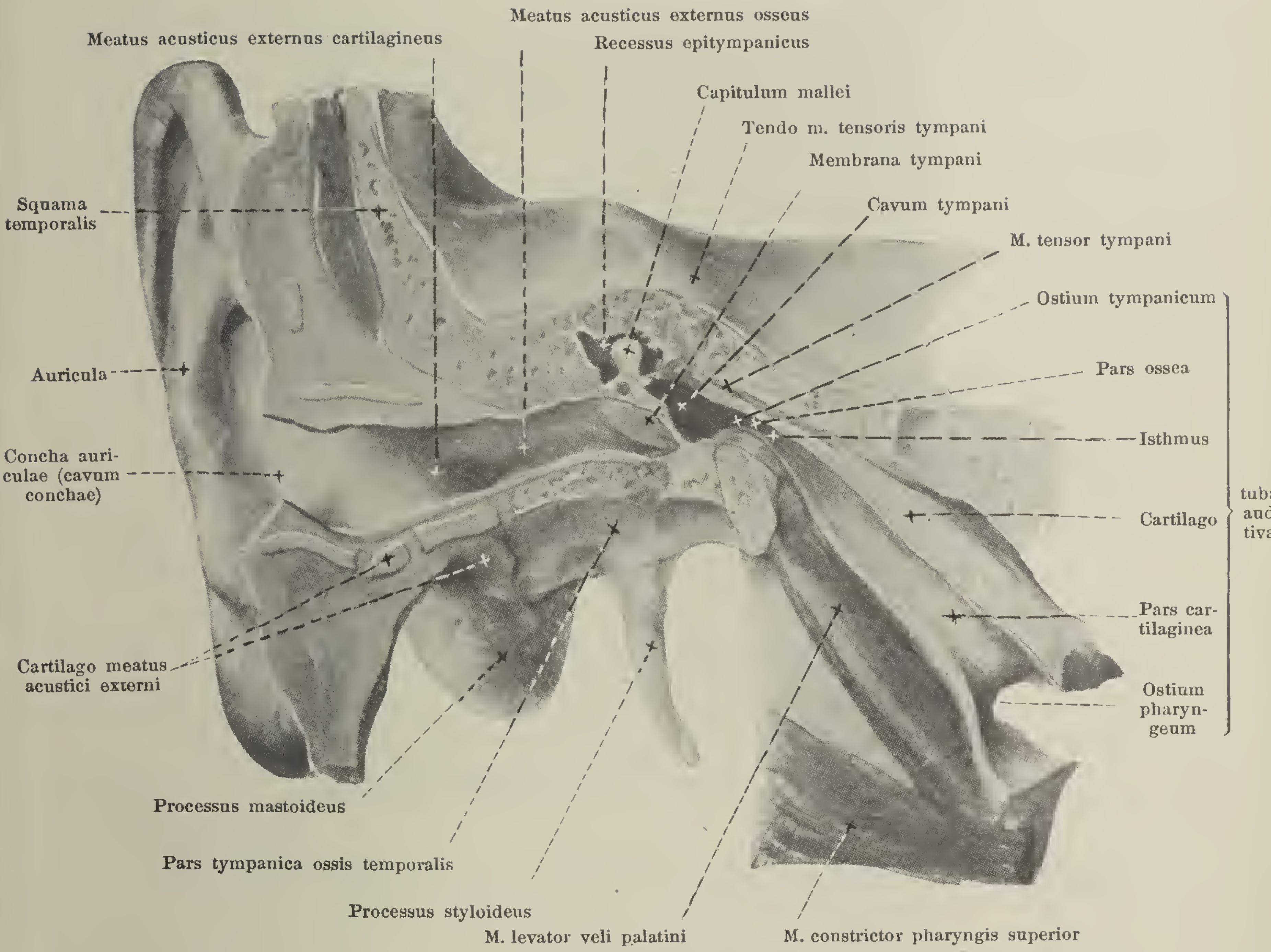


932.

Lachrymal canals of the right eye, viewed from in front.
The medial portion of the lid-plates have been cut off, the lig. palpebrale mediale has been removed, and the canalis nasolacrimalis opened.)

Apparatus lacrimalis, *lachrymal apparatus*, consists of the *lachrymal gland*, and of the lachrymal canals, namely: *ductus lacrimales*, *saccus lacrimalis* and *ductus nasolacrimalis*. The *lachrymal gland* (see Figs. 911, 913, 919, 922, 929 and 930) is of a reddish gray color and consists of an upper and lower part which are separated from one another by the tendinous expansion of the m. levator palpebrae superioris. The upper part, *glandula lacrimalis superior,* is oval in shape and varies somewhat in size; it lies directly under the periorbita, in the fossa glandulae lacrimalis of the frontal bone, and is attached there by laminae of connective tissue; it reaches lateralward as far as the suture between the frontal and zygomatic bones. The lower, smaller part, *glandula lacrimalis inferior,* is more loosely constructed and reaches downward as far as the fornix conjunctivae superior and the lateral angle of the eye. Its *excretory ducts, ductuli excretorii [glandulae lacrimalis],* consist of approximately twelve delicate tubules which open in the conjunctival sack, just in front of the fornix, the lowermost and largest at the level of the lateral angle of the eye (see Fig. 931); the ducts of the upper gland perforate the lower gland.

The *tears, lacrimae,* moisten the free surface of the eyeball, are dispersed over it by the lid-beating and when the lids are closed, can run medianward in a narrow triangular slit, sometimes present, *rivus lacrimalis,* which remains open between the anterior surface of the bulbus and the free margins of the lids. They pass into the lacus lacrimalis and thence through the puncta lacrimalia (see p. 818) into the *ductus lacrimales*, *lachrymal tubules.* These are two thin-walled canals, about 10 mm long, which run at first for a short distance vertically (and somewhat medially); they then turn medianward and grasp the lig. palpebrale mediale between them, and open, finally, into the tear sack, usually separately, more rarely by a common terminal portion; at the bend of each duct is a small pear-shaped dilatation, *ampulla ductus lacrimalis.* The *tear sack, saccus lacrimalis*, (see also Figs. 925 and 929), is a canal, closed above like a blind-sack, which goes over below without boundary, into the ductus nasolacrimalis and above receives the lachrymal ducts laterally. It fills up the fossa sacci lacrimalis completely, but projects with its pointed cupola, *fornix sacci lacrimalis,* not at all or only slightly beyond the *lig. palpebrale mediale*, which stretches out as a narrow curved plate from the crista lacrimalis posterior to the proc. frontalis maxillae and is fused with the wall of the tear sack by means of loose tissue. Laterally the tear sack is also covered by the periorbita which is stretched out between the cristae lacrimales. Its lumen is a sagittally placed slit. The *nasolachrymal duct, ductus nasolacrimalis,* a membranous canal filling up the canalis nasolacrimalis, is narrowest at the upper end of the bony canal and possesses a wider lumen than the tear sack. Its mucous membrane often shows small folds and pockets. It opens in the lower nasal meatus by passing obliquely through the mucous membrane, usually by a longitudinally oval slit; the lip of mucous membrane which guards this opening above is called the *plica lacrimalis [Hasneri]* (see Fig. 983).



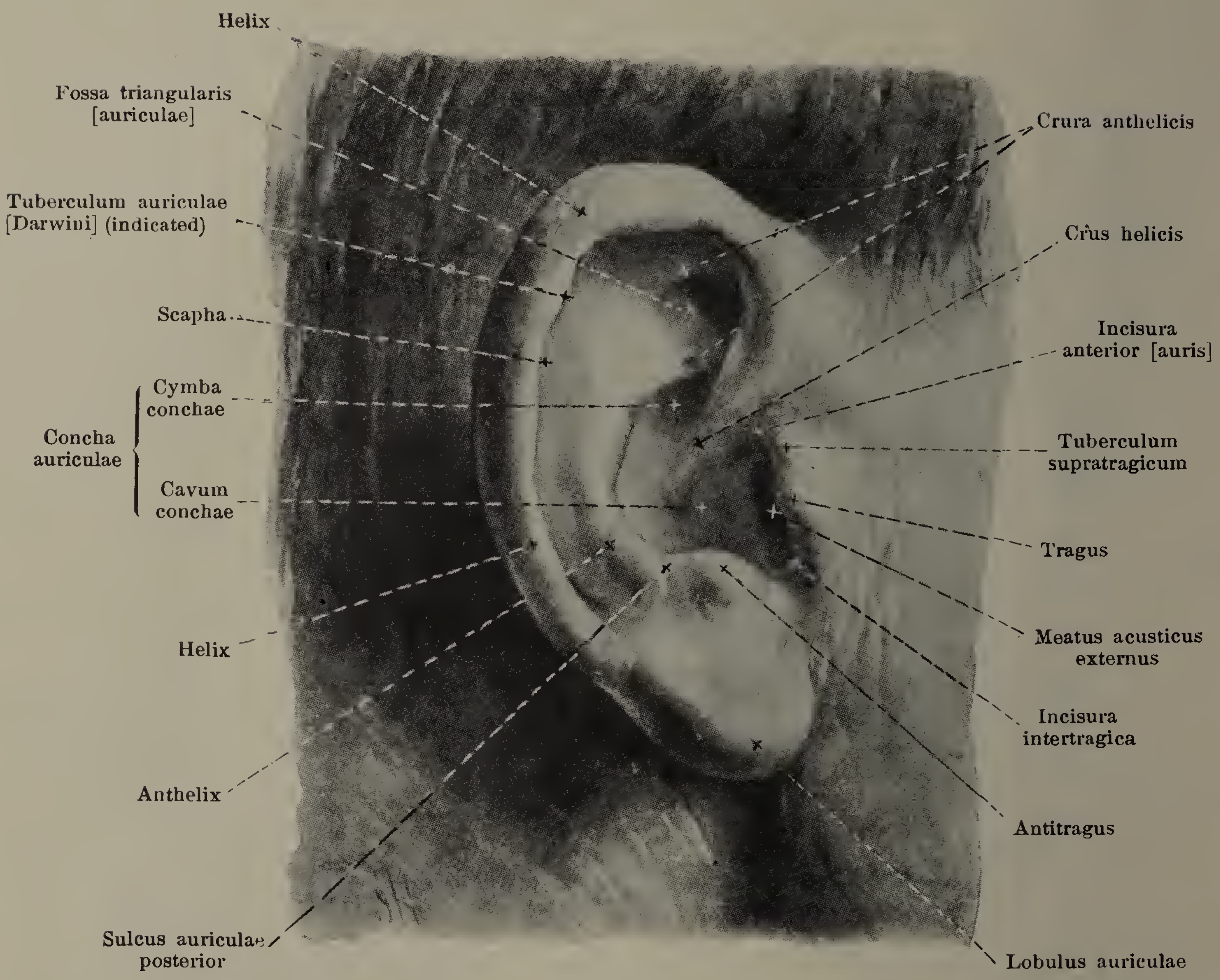
933. General view of the right external ear and middle ear, looked at from in front and externally.

(The external ear has been opened by a frontal section; the tympanic cavity and Eustachian tube have been opened by a vertical section carried obliquely medianward and ventralward.)

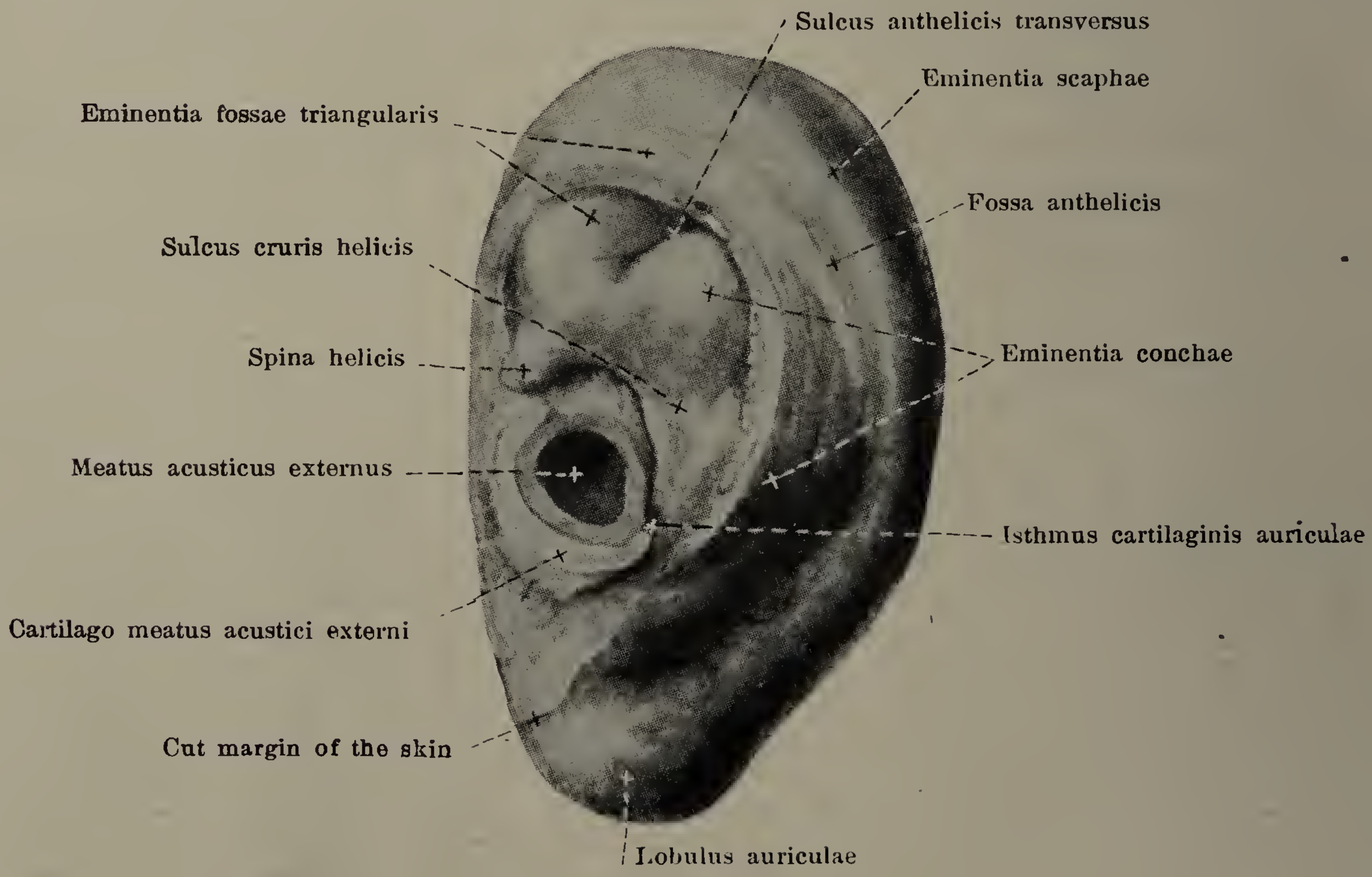
Organon auditus, *organ of hearing,* is divisible into the *external ear, auris externa,* the *middle ear, auris media,* and the *internal ear, auris interna.*

Auris externa, *external ear* (see also Figs. 934—941), is formed of the *outer ear proper, auricula,* and the *external auditory canal, meatus acusticus externus.*

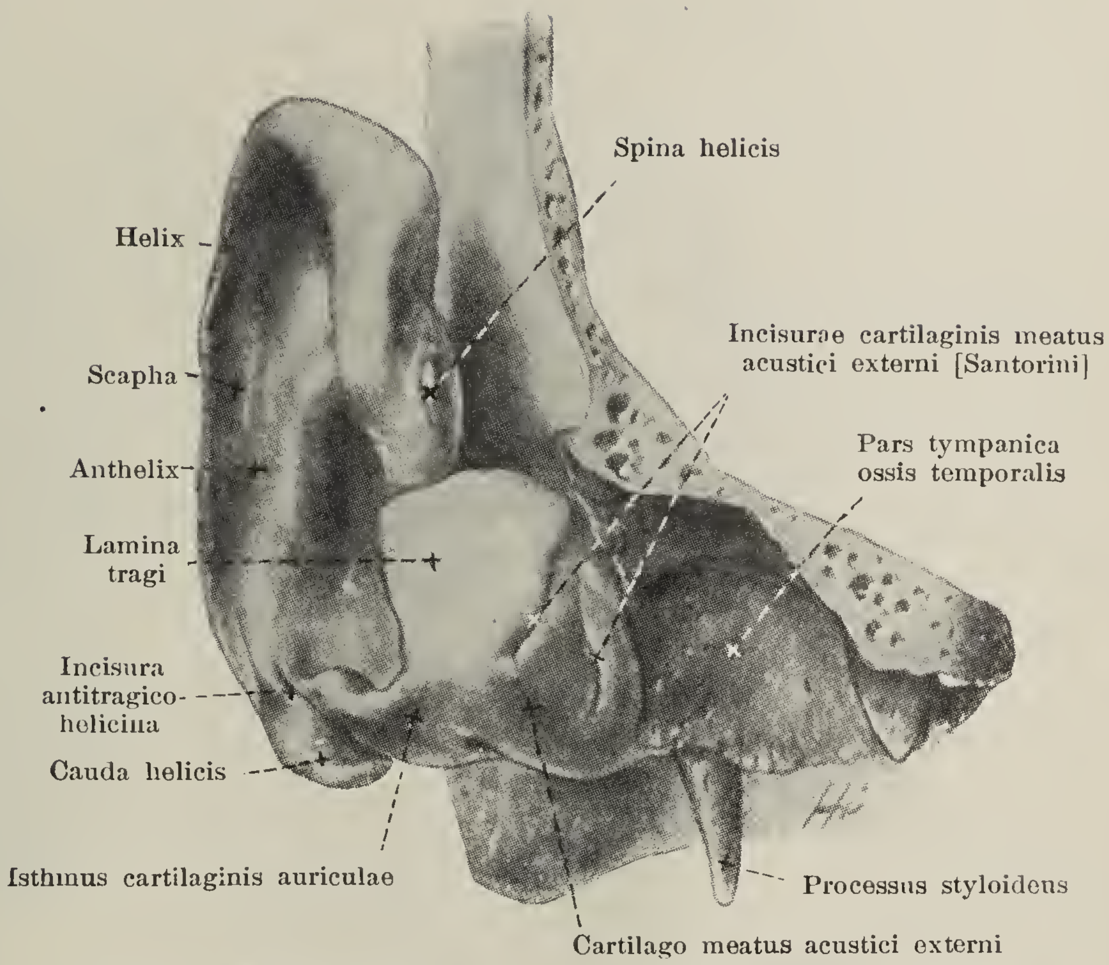
The *auricula,* or *outer ear proper* (see also Figs. 934—941), is an oblong, flat fold of skin, in general irregularly shell-shaped, which surrounds the opening of the external acoustic canal; it is approximately twice as long as broad, and is bent in and out in different directions, but so that its lateral surface is essentially concave while its medial surface, turned toward the skull, is convex. It contains within it the *ear cartilage, cartilago auriculae,* consisting of elastic cartilage, which is chiefly covered only by thin skin and so determines the essential form of the auricle, but below it is somewhat shorter than this. The ear cartilage is continued in front and below directly into the cartilago meatus acustici externi (see Figs. 936 and 937) and together with it forms a half tube, open above; the posterior limb of the tube belonging to the ear cartilage is connected with the anterior limb formed by the cartilage of the acoustic canal and of the lamina tragi by a narrow intermediate piece, *isthmus cartilaginis auriculae,* the lateral margin of which forms the deepest part of the *incisura intertragica* (see p. 825) and the medial margin of which helps to bound the corresponding medial notch between the two limbs, the *incisura terminalis.*



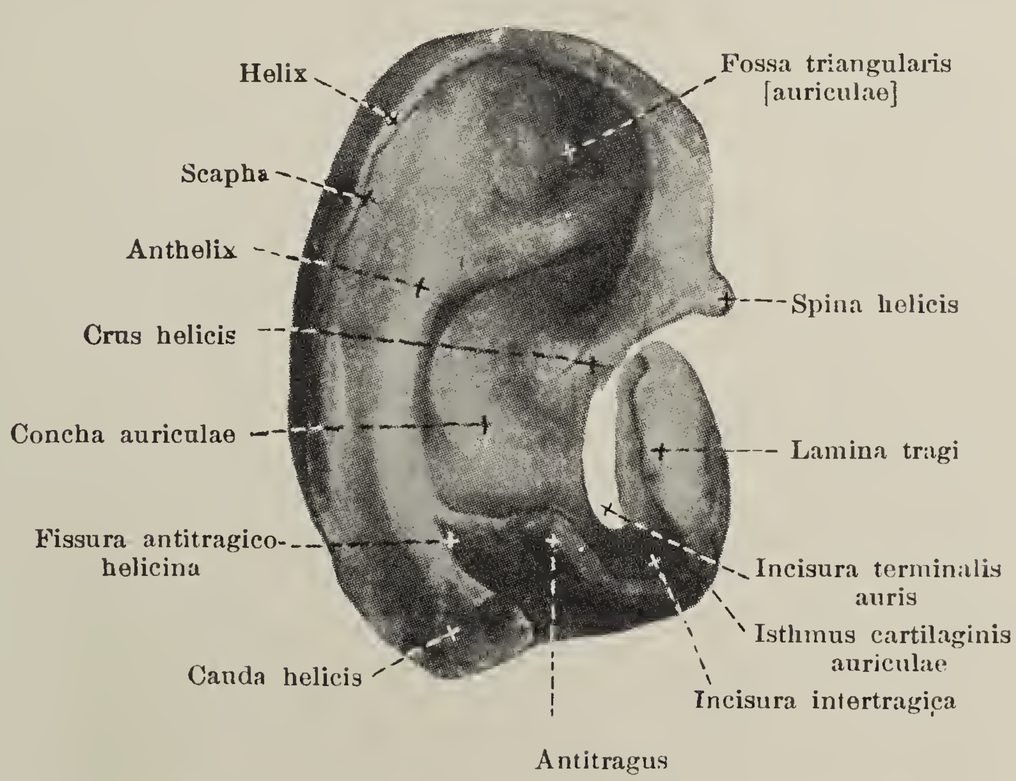
934. Right auricle, viewed from without (drawn from life).


Sulcus anthelicis transversus
Eminentia fossae triangularis
Eminentia scaphae
Fossa anthelicis
Sulcus cruris helicis
Spina helicis
Eminentia conchae
Meatus acusticus externus
Isthmus cartilaginis auriculae
Cartilago meatus acustici externi
Cut margin of the skin
Lobulus auriculae

935. Right auricle, viewed from within.
(The auricle has been removed from the head by a clean cut.)

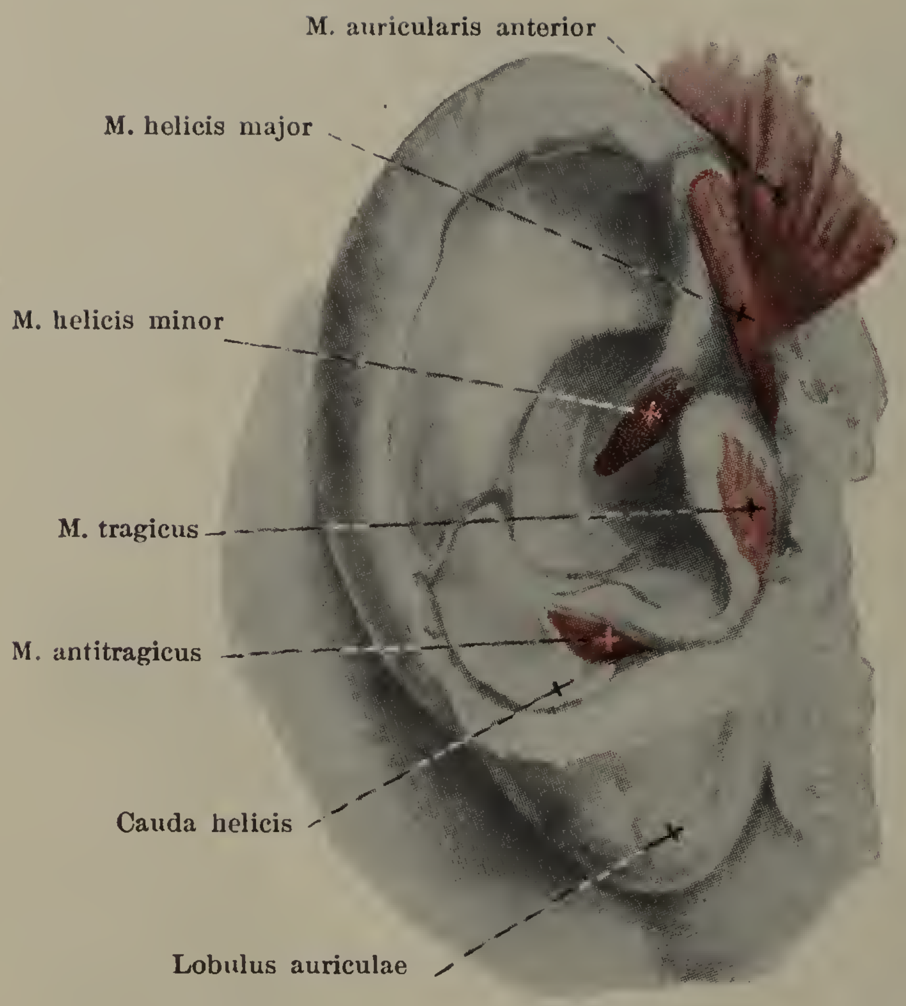

Spina helicis
Helix
Incisurae cartilaginis meatus acustici externi [Santorini]
Scapha
Pars tympanica ossis temporalis
Anthelix
Lamina tragi
Incisura antitragicohelicina
Cauda helicis
Isthmus cartilaginis auriculae
Processus styloideus
Cartilago meatus acustici externi

936. Right ear cartilage, with its attachments to the bone,
viewed from in front and externally.

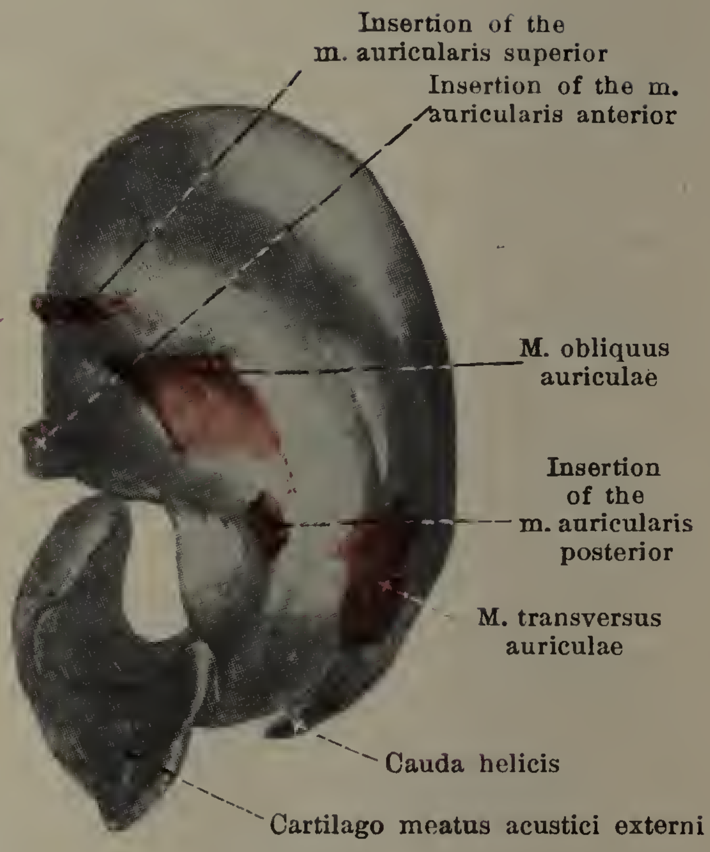


937. Right ear cartilage, isolated,
viewed from without.

Cartilago auriculae (continued) (see also Figs. 934, 935 and 938—940). Its posterior and superior markedly curved margin, turned up outward, *helix (ear border)*, arises from the cavity of the auricle by means of a slightly curved projection, *crus helicis*, and at its anterior margin sends a small nodule, *spina helicis*, forward and downward; below it ends in a plate, *cauda helicis*, curved around forward, which is separated from the neighboring antitragus by a deep notch, *incisura antitragicohelicina;* its free, tolerably sharp edge often possesses, in the upper part of the posterior portion, a small process, *tuberculum auriculae [Darwini]*. Running approximately parallel to the helix upon the lateral surface is an elongated ridge, *anthelix;* it begins in front and above under the helix by two limbs which converge behind, *crura anthelicis*, which include between them a flat depression, *fossa triangularis [auriculae];* behind, it is separated from the helix by an elongated depression, *scapha*, and below it goes over into the antitragus, often insensibly, sometimes separated from it by a depression, *sulcus auriculae posterior*. The lower part of the ear cartilage turns around near the cauda helicis and forms a small triangular plate, projecting free upward, the *antitragus*, which is separated in front by a shallower or deeper notch, *incisura intertragica*, from the *lamina tragi*. This quadrangular disc of cartilage is the lateral part of the cartilago meatus acustici (see pp. 823 and 829) and forms the basis of the *tragus* of the auricle; it overlies the opening of the external acoustic canal like a valve in front, and not rarely presents on its upper part a small tubercle, *tuberculum supratragicum*. The deep depression between the anthelix, tragus and antitragus, is called the *concha auriculae* and is incompletely divided by the crus helicis into a smaller upper part, *cymba conchae*, and a larger lower part, *cavum conchae*, which leads in its anterior portion directly into the meatus acusticus externus. The projections present on the convex medial surface of the auricle correspond to the fossa-like depressions of the concave lateral surface, and are correspondingly designated: *eminentia fossae triangularis, eminentia scaphae* and *eminentia conchae.*



938. Cartilage of right ear with the muscles,
partly dissected out of the auricle, viewed from the outside.


Insertion of the m. auricularis superior
Insertion of the m. auricularis anterior
M. obliquus auriculae
Insertion of the m. auricularis posterior
M. transversus auriculae
Cauda helicis
Cartilago meatus acustici externi

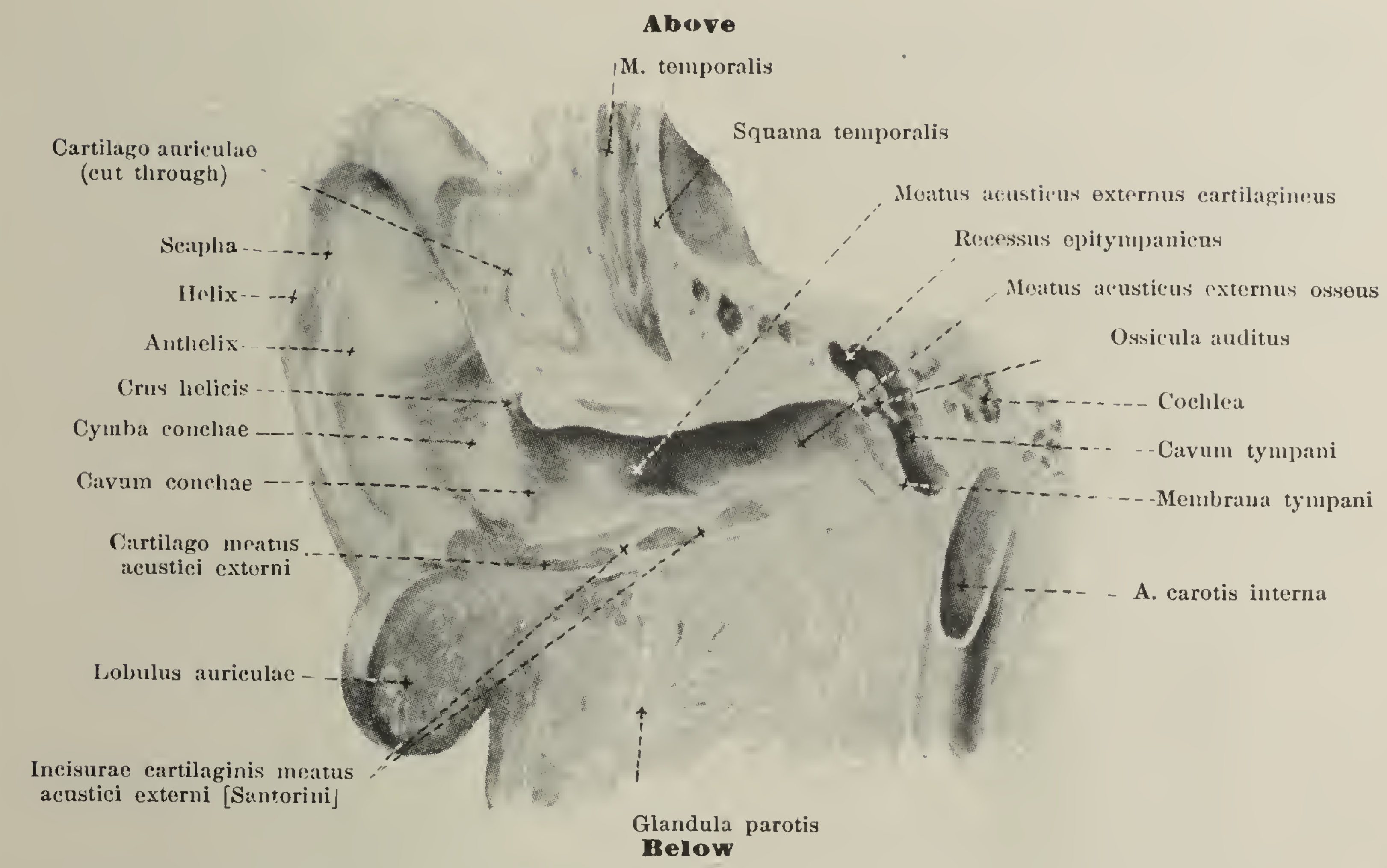
939. Cartilage of right ear, isolated, with the muscles,
viewed from the inside.

Cartilago auriculae (continued) (see also Figs. 935—937), medial, convex surface. The eminentia fossae triangularis is separated from the eminentia conchae by the ***sulcus anthelicis transversus;*** it corresponds to the lower crus anthelicis, and goes over arch-like into the long *fossa anthelicis* which is directed downward and which causes the bulging of the anthelix on the lateral surface. Upon the surface of the eminentia conchae running approximately horizontally is the flat ***sulcus cruris helicis,*** corresponding to the crus helicis.

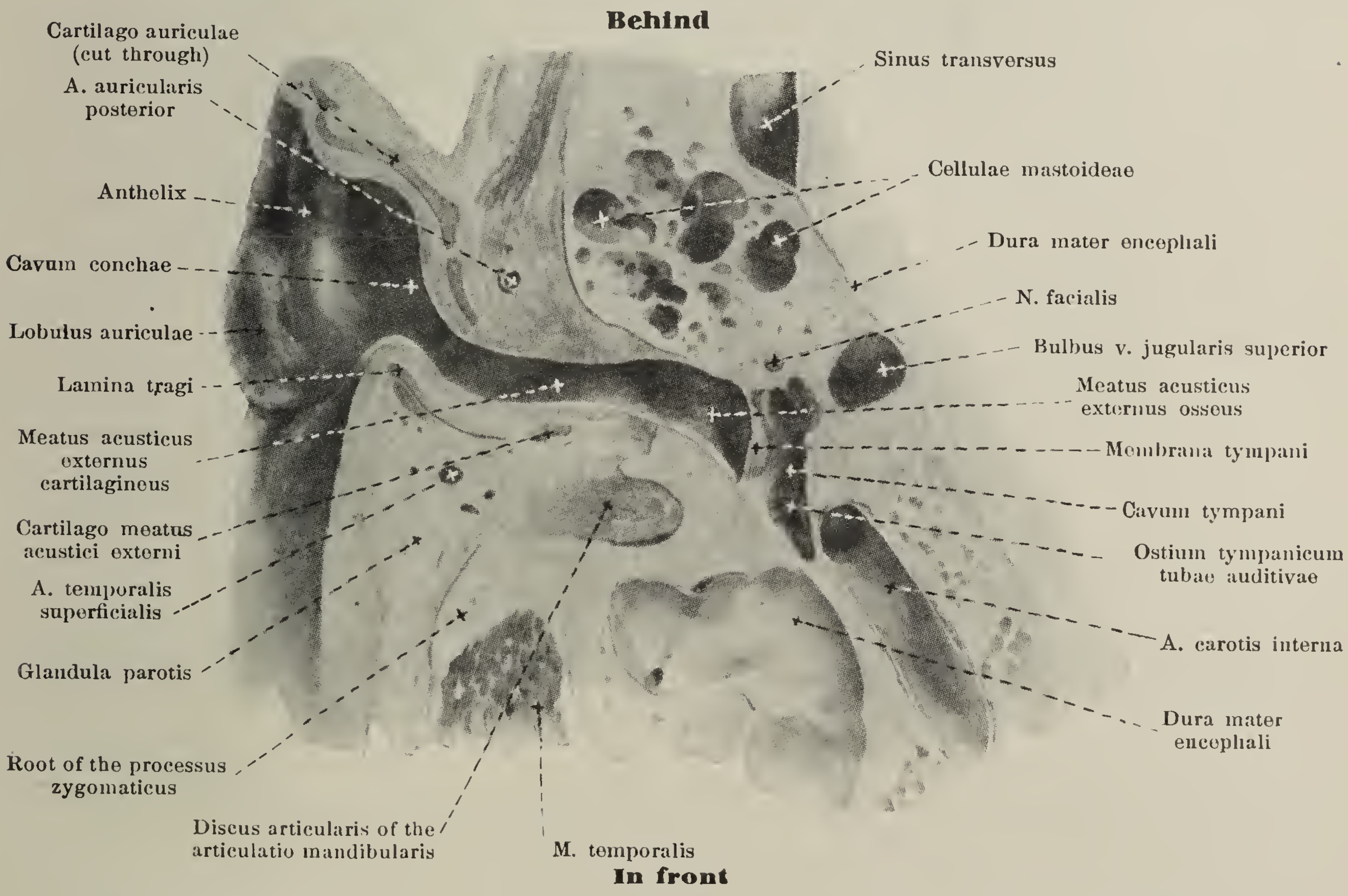
The cartilage of the auricle is fastened to the temporal bone by a more or less connecting fibre-mass in which are distinguishable three bands of fibres, ***ligamenta auricularia [Valsalvae]*** (not illustrated): the ***lig. auriculare anterius*** from the root of the zygomatic arch to the helix and lamina tragi, the ***lig. auriculare superius*** from the upper margin of the porus acusticus externus to the spina helicis and the ***lig. auriculare posterius*** from the lateral surface of the proc. mastoideus to the eminentia conchae.

The cartilage of the ear possesses small intrinsic muscles composed of striped fibres; they are pale, usually six in number, of very variable development, all innervated by the n. facialis. Upon the lateral surface: ***m. helicis major*** from the spina helicis upward to the helix; ***m. helicis minor*** upon the crus helicis; ***m. tragicus*** upon the lamina tragi; ***m. antitragicus*** upon the antitragus and partly to the cauda helicis; these two are said to narrow the entrance to the external acoustic meatus. Upon the medial surface: ***m. transversus auriculae,*** horizontal, from the eminentia scaphae to the eminentia conchae; ***m. obliquus auriculae,*** nearly vertical, from the eminentia fossae triangularis to the eminentia conchae.

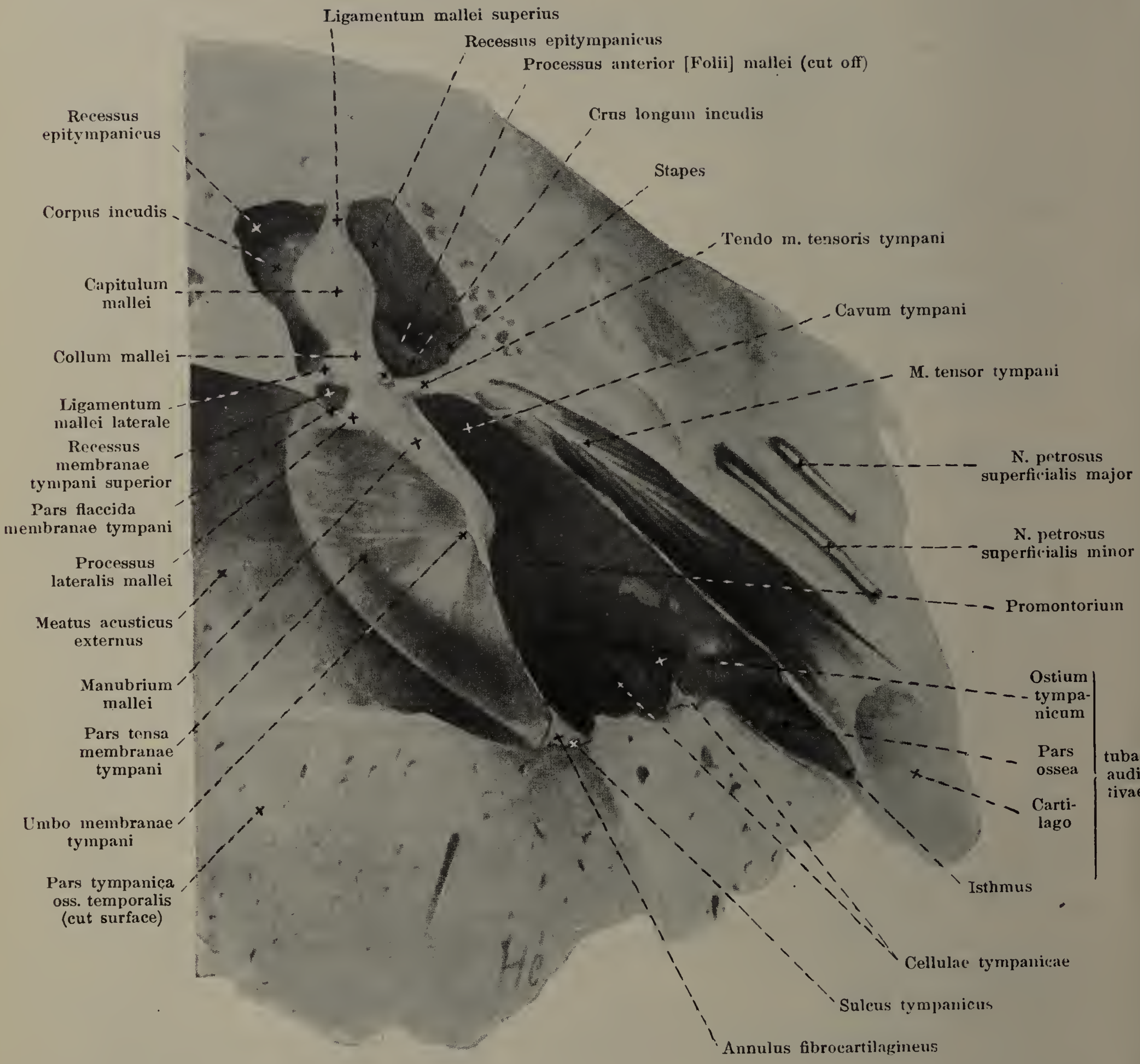
The ***auricula, auricle*** (see also Figs. 934 and 935) (O. T. pinna), is completely covered by the skin on its lateral surface which bridges over the notch between the crus helicis and lamina tragi and transforms it into a groove, ***incisura anterior [auris],*** and is then continued into the skin of the cheek. On the medial surface the skin covers only the upper and posterior part of the ear cartilage whence it curves around into the skin of the head. Below, the skin over the cauda helicis and the antitragus forms a flat, rounded, fatty duplicature, ***lobulus auriculae, lobule of the ear,*** which hangs down and is very variable in different individuals.



940. Vertical section through the right external acoustic canal, viewed from in front.


Behind
Cartilago auriculae (cut through)
A. auricularis posterior
Sinus transversus
Cellulae mastoideae
Anthelix
Dura mater encephali
Cavum conchae
N. facialis
Lobulus auriculae
Bulbus v. jugularis superior
Lamina tragi
Meatus acusticus externus osseus
Meatus acusticus externus cartilagineus
Membrana tympani
Cavum tympani
Cartilago meatus acustici externi
Ostium tympanicum tubae auditivae
A. temporalis superficialis
A. carotis interna
Glandula parotis
Dura mater encephali
Root of the processus zygomaticus
Discus articularis of the articulatio mandibularis
M. temporalis
In front

941. Horizontal section through the right external acoustic canal, viewed from above.


Ligamentum mallei superius
Recessus epitympanicus
Processus anterior [Folii] mallei (cut off)
Crus longum incudis
Stapes
Tendo m. tensoris tympani
Cavum tympani
M. tensor tympani
N. petrosus superficialis major
N. petrosus superficialis minor
Promontorium
Ostium tympanicum
Pars ossea
Cartilago
tubae auditivae
Isthmus
Cellulae tympanicae
Sulcus tympanicus
Annulus fibrocartilagineus
Recessus epitympanicus
Corpus incudis
Capitulum mallei
Collum mallei
Ligamentum mallei laterale
Recessus membranae tympani superior
Pars flaccida membranae tympani
Processus lateralis mallei
Meatus acusticus externus
Manubrium mallei
Pars tensa membranae tympani
Umbo membranae tympani
Pars tympanica oss. temporalis (cut surface)
He

942. Vertical section through the right ear-drum,
viewed from in front. Magnification: 6:1.

(The section has been carried approximately frontally through the external acoustic canal; medial from this it has been carried obliquely forward and medianward.)

Meatus acusticus externus, external acoustic canal (see Figs. 933—937 and 940—942), is divisible into a lateral portion, the *cartilaginous acoustic canal, meatus acusticus externus cartilagineus,* and a medial part, the *bony external acoustic canal, meatus acusticus externus osseus.*

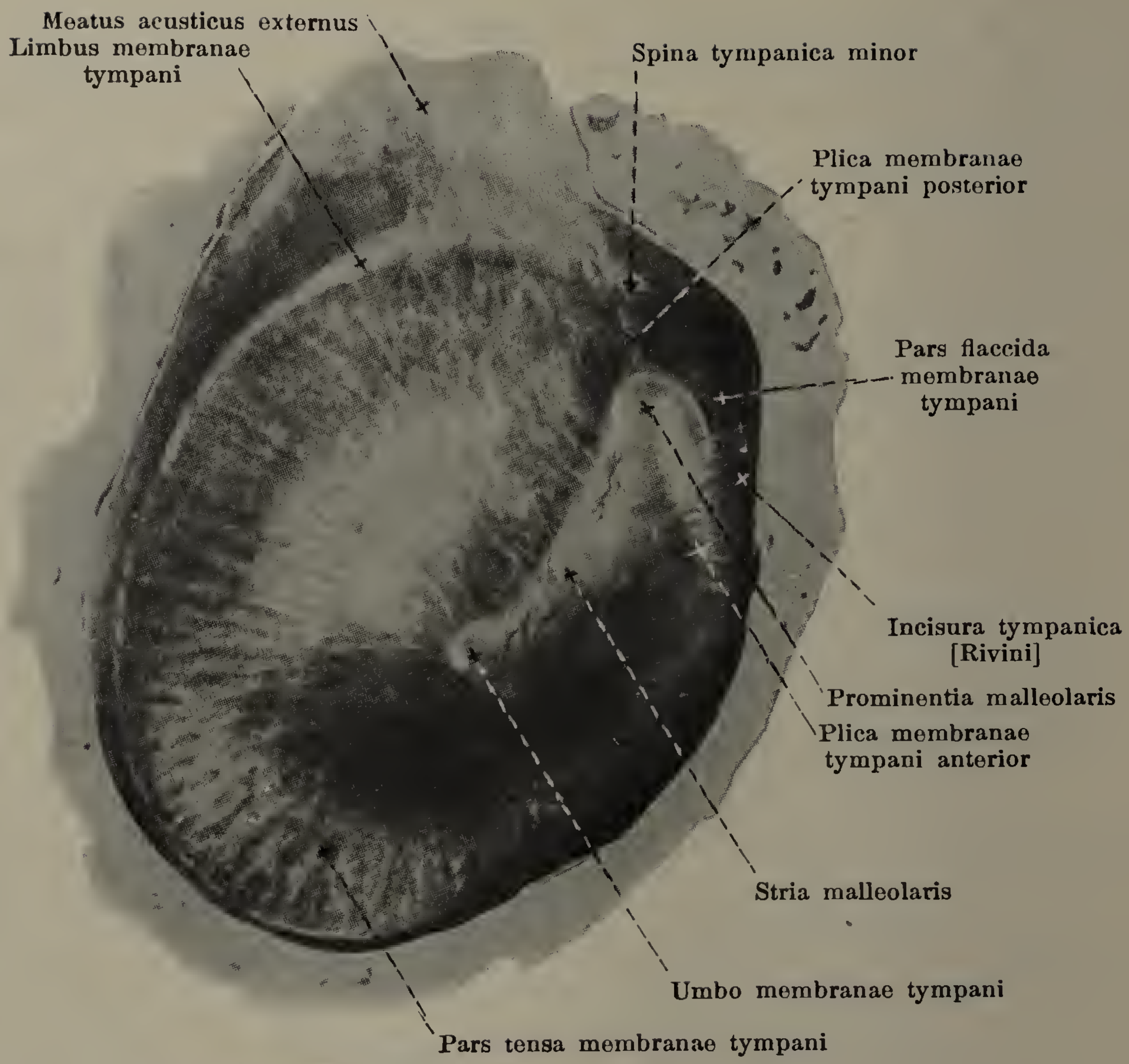
The *meatus acusticus externus cartilagineus* (see Figs. 933—942) begins laterally in the cavum conchae (see p. 825) and reaches medianward as far as the porus acusticus externus. Its anterior and inferior walls are formed by a groove-like cartilage, *cartilago meatus acustici externi,* which is continued laterally into the lamina tragi (see p. 825) and behind is connected with the cartilago auriculae (see p. 823). This cartilage is usually interrupted in two places by approximately vertical slits, *incisurae cartilaginis meatus acustici externi [Santorini],* which are filled up by connective tissue; it is fastened firmly (see Fig. 936) in front and above to the posterior root of the proc. zygomaticus, in front and below to the lateral margin of the pars tympanica oss. temporalis. The upper and posterior somewhat shorter wall of the cartilaginous acoustic canal is formed by a connective tissue plate which unites the upper margin of the cartilage with the cartilage of the ear and with the bone and is attached medially to the upper and posterior circumference of the porus acusticus externus (and to the spina supra meatum).

The *meatus acusticus externus osseus* belongs to the temporal bone (see p. 9); it begins laterally with the *porus acusticus externus* and possesses smooth walls of which the anterior and inferior are slightly convex toward the lumen and longer, the superior and inferior slightly concave and shorter. Medianward it ends in the *sulcus tympanicus* and the *incisura tympanica [Rivini]* (see p. 15 and Figs. 965 and 966).

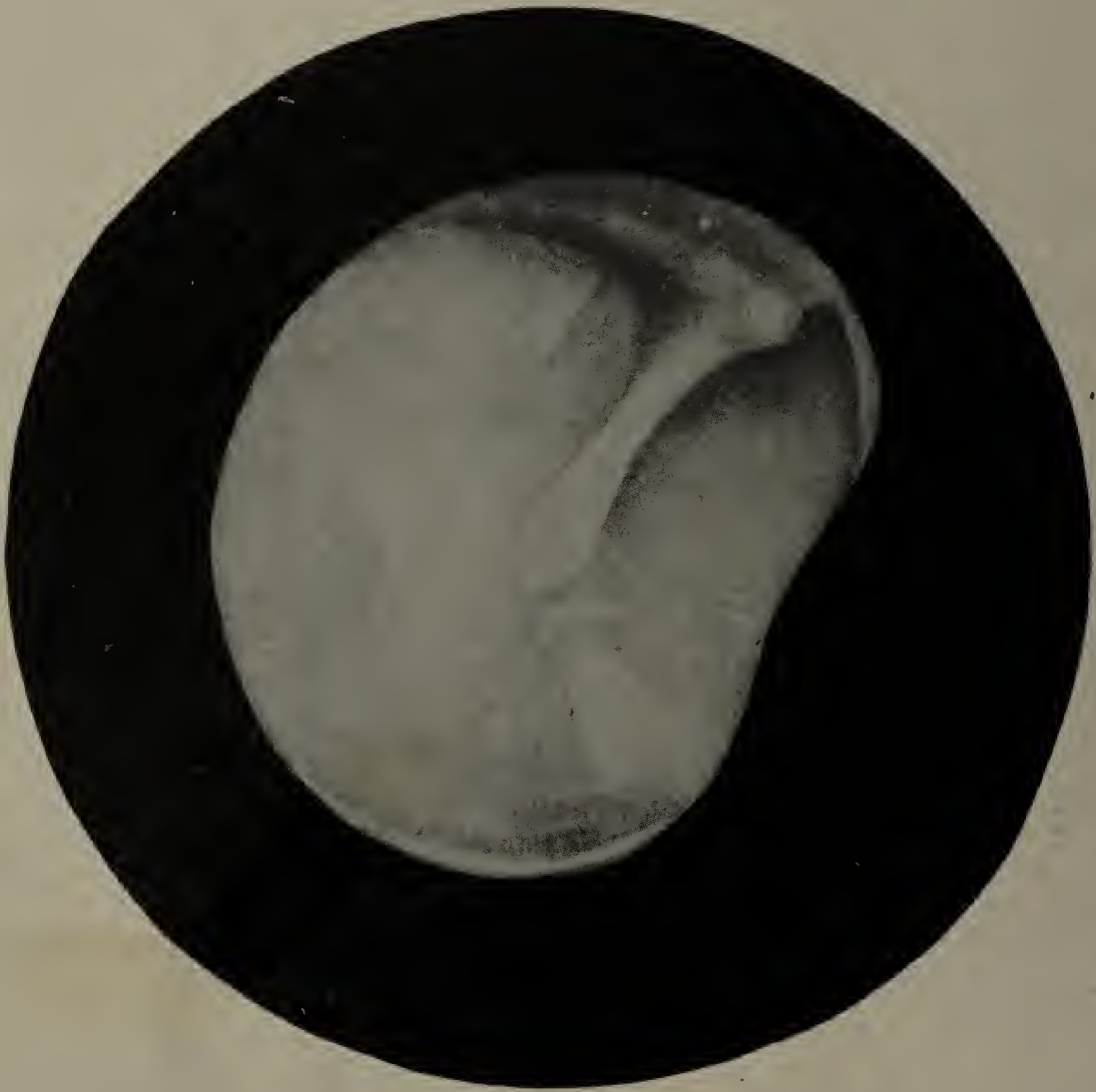
The *meatus acusticus externus* (see Figs. 933, 940 and 941) is lined internally by a thin perichondrium and periosteum and clothed by a blind-sack-like continuation of the external skin, which in the region of the pars tympanica is thinner than above and inseparably united with the periosteum, and covers the lateral surface of the membrana tympani as an especially thin layer. In the region of the cartilaginous part are to be found numerous strong hairs, called *tragi (ear-hairs)* and the *glandulae ceruminosae, ear-wax glands,* which secrete the *cerumen, ear-wax.* The acoustic canal is subject to numerous individual variations in length, lumen and course. In general it is directed horizontally and frontally, but slightly curved like the letter S in a horizontal and vertical plane, so that in the horizontal direction it is curved laterally so as to be convex forward, and medially so as to be convex backward; in the vertical direction it is convex below laterally, and convex above medially. The lateral portion of the curvature belongs to the cartilaginous part and is longer than the medial. The cross-section of the lumen is irregularly oblong elliptical; its long axis stands approximately vertically lateralward and medianward approaches the horizontal; the narrowest part is the junction between the cartilaginous and the bony portion. The medial boundary is formed by the membrana tympani. It is due to the oblique position of the latter that the anterior and inferior walls of the acoustic canal are longer than the posterior and superior.

The *ear-drum membrane, membrana tympani* (see Figs. 933, 940—943 and 946—948), is a very thin, smooth membrane (about 0,1 mm thick), stretched out between the external acoustic canal and the cavity of the tympanum, separating these two from one another completely and thus separating also the outer ear from the middle ear. It is subject to marked individual variations in form, size and obliquity.

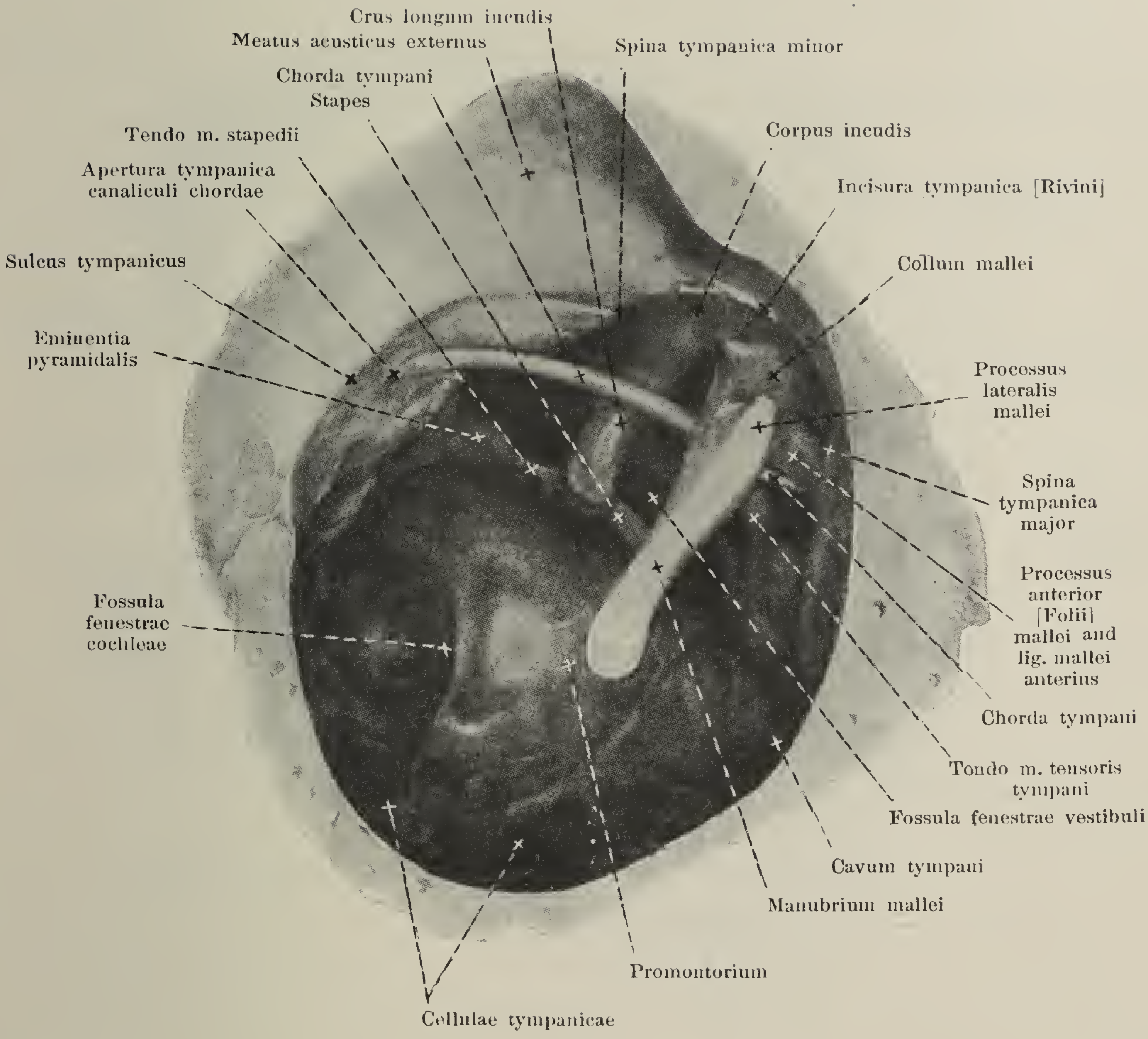
The membrana tympani is usually elliptical, sometimes quite oval and has a longitudinal diameter (obliquely from above and in front downward and backward) from 9—10 mm and a transverse diameter of 8—9 mm. It is stretched out in the sulcus tympanicus and in the incisura tympanica [Rivini] and is so inclined in the body that a plane passing through the sulcus tympanicus looks medianward, backward and upward; corresponding to this is the variable length of the walls of the external acoustic canal (see above). In the new-born, the incline is such that the membrana tympani stands almost horizontal. The small, anterior upper portion, situated within the incisura tympanica, is loose and is called the *pars flaccida;* it reaches downward as far as the button-like *prominentia malleolaris* pushed forward by the proc. lateralis mallei, and as far as two folds going out from the spinae tympanicae and converging toward this point, namely the shorter, *anterior* and the longer, *posterior ear-drum membrane folds, plica membranae tympani anterior* and *posterior.* The larger inferior portion of the membrana tympani is tightly stretched and is called the *pars tensa;* it is drawn in, so as to be funnel-shaped medianward, by the tip of the handle of the hammer imbedded in its substance, so that upon its lateral surface there occurs a flat depression, *umbo membranae tympani;* the walls of this funnel are curved so as to be convex outward. The umbo does not lie exactly in the middle but is displaced somewhat downward and forward. On the external surface one sees a whitish stripe, *stria malleolaris,* passing from the prominentia malleolaris to the umbo, due to the handle of the hammer situated there showing through; it runs obliquely from in front and above backward and downward.


Meatus acusticus externus
Limbus membranae tympani
Spina tympanica minor
Plica membranae tympani posterior
Pars flaccida membranae tympani
Incisura tympanica [Rivini]
Prominentia malleolaris
Plica membranae tympani anterior
Stria malleolaris
Umbo membranae tympani
Pars tensa membranae tympani

943. Right ear-drum, viewed from the outside, from in front and below. Magn.: 6 : 1.



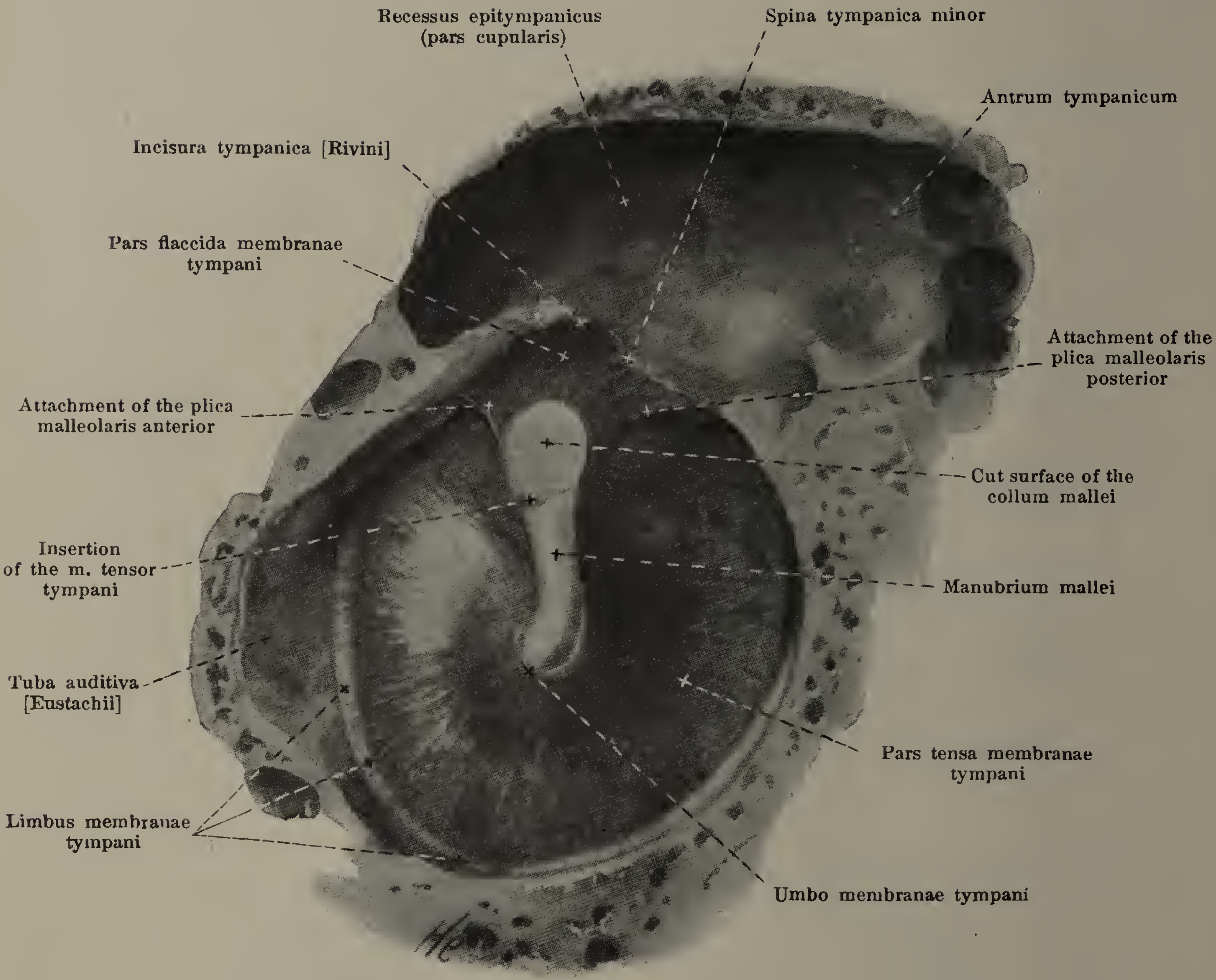
944. Right ear-drum as viewed through speculum; from life (after O. Körner). Magn.: ca. 6 : 1.


Crus longum incudis
Meatus acusticus externus
Spina tympanica minor
Chorda tympani
Stapes
Tendo m. stapedii
Corpus incudis
Apertura tympanica canaliculi chordae
Incisura tympanica [Rivini]
Sulcus tympanicus
Collum mallei
Eminentia pyramidalis
Processus lateralis mallei
Spina tympanica major
Fossula fenestrae cochleae
Processus anterior [Folii] mallei and lig. mallei anterius
Chorda tympani
Tendo m. tensoris tympani
Fossula fenestrae vestibuli
Cavum tympani
Manubrium mallei
Promontorium
Cellulae tympanicae

945. Small bones of the right ear,

after removal of the ear-drum, viewed from the outside, in front and below.
Magnification: 6:1.

The *membrana tympani* (continued) (see also Figs. 933, 940—943 and 946—948) is fastened by a somewhat thickened margin, *limbus membranae tympani,* in the sulcus tympanicus by means of the fibrocartilaginous *circular pad, annulus fibrocartilagineus,* and is there sharply marked off from its surroundings; in the incisura tympanica [Rivini] the fibrocartilaginous ring is absent and the skin of the acoustic canal goes over gradually and without sharp limit into the membrane. In the ear-drum we distinguish four sheets. On its lateral surface it is covered by the *stratum cutaneum,* a continuation of the external skin which is somewhat thicker in the region of the stria malleolaris but is elsewhere very thin. Following upon this is a connective tissue membrane, composed of a lateral layer of radial fibres, *stratum radiatum,* in which stiff fibres run approximately radial to the handle of the hammer, and of a medial layer of circular fibres, *stratum circulare,* in which the fibres are arranged in circles closer together at the periphery than near the centre; both layers are connected with the annulus fibrocartilagineus; they are lacking in the pars flaccida. The medial surface is covered by the *stratum mucosum,* a continuation of the mucous membrane of the tympanic cavity.

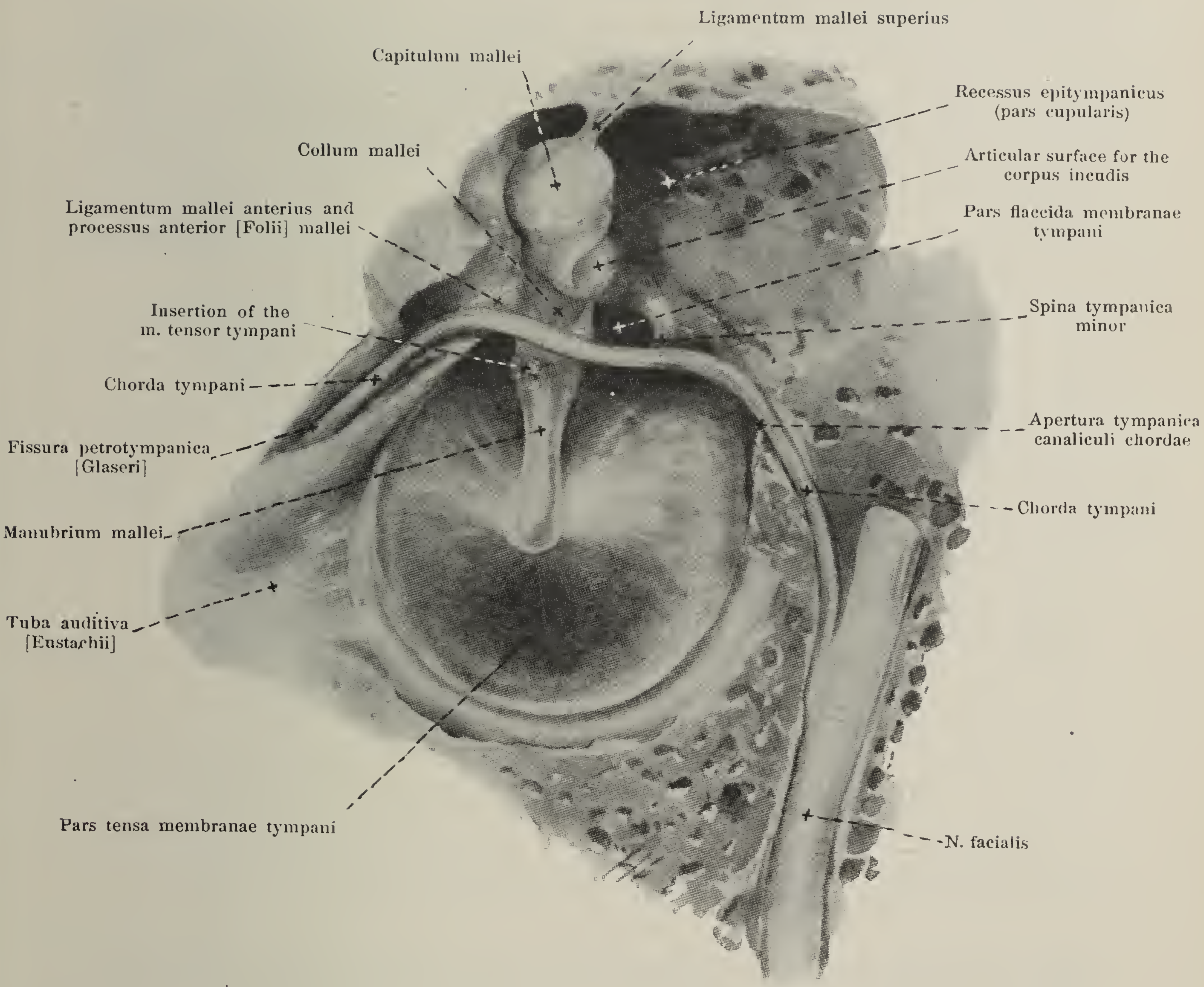

Recessus epitympanicus (pars cupularis)
Spina tympanica minor
Antrum tympanicum
Incisura tympanica [Rivini]
Pars flaccida membranae tympani
Attachment of the plica malleolaris posterior
Attachment of the plica malleolaris anterior
Cut surface of the collum mallei
Insertion of the m. tensor tympani
Manubrium mallei
Tuba auditiva [Eustachii]
Pars tensa membranae tympani
Limbus membranae tympani
Umbo membranae tympani

946. Right ear-drum with handle of hammer, viewed from within, behind and above. Magnification: 6:1.

(The chorda tympani and the head of the hammer, with the folds of mucous membrane have been removed.)

Auris media, middle ear (see Figs. 933, 940—942, 945, 947, 948 and 952—957), is formed by the *cavum tympani* with the *ossicula auditus* and by the *tuba auditiva [Eustachii]*.

The *cavum tympani, tympanic* or *ear-drum cavity* (see Figs. 933, 940—942), lies within the temporal bone so that it is bounded laterally and in front by the squama and the pars tympanica, medially and behind by the pars petrosa. It is a slit-like air-containing space lined by mucous membrane which is continuous behind and lateralward with the air-containing cellulae mastoideae, while in front and medianward it opens into the pharynx through the tuba auditivæ [Eustachii]; laterally it is completely separated by the membrana tympani from the external acoustic meatus and medially by the basis stapedis and the membrana tympani secundaria from the internal ear. Its slit-like space forms with the median plane an angle of about 45°. Its form is comparable with that of a biconcave lens, the broad surfaces of which are placed vertically and correspond to the medial, posterior and lateral, anterior walls and the margin of which forms a narrow anterior, inferior, posterior and superior wall; the distance between the medial and lateral walls varies much in different individuals, but is wider behind and above than in front and below and is least between the umbo and the promontorium.


Ligamentum mallei superius
Capitulum mallei
Recessus epitympanicus (pars cupularis)
Collum mallei
Articular surface for the corpus incudis
Ligamentum mallei anterius and processus anterior [Folii] mallei
Pars flaccida membranae tympani
Insertion of the m. tensor tympani
Spina tympanica minor
Chorda tympani
Apertura tympanica canaliculi chordae
Fissura petrotympanica [Glaseri]
Chorda tympani
Manubrium mallei
Tuba auditiva [Eustachii]
Pars tensa membranae tympani
N. facialis

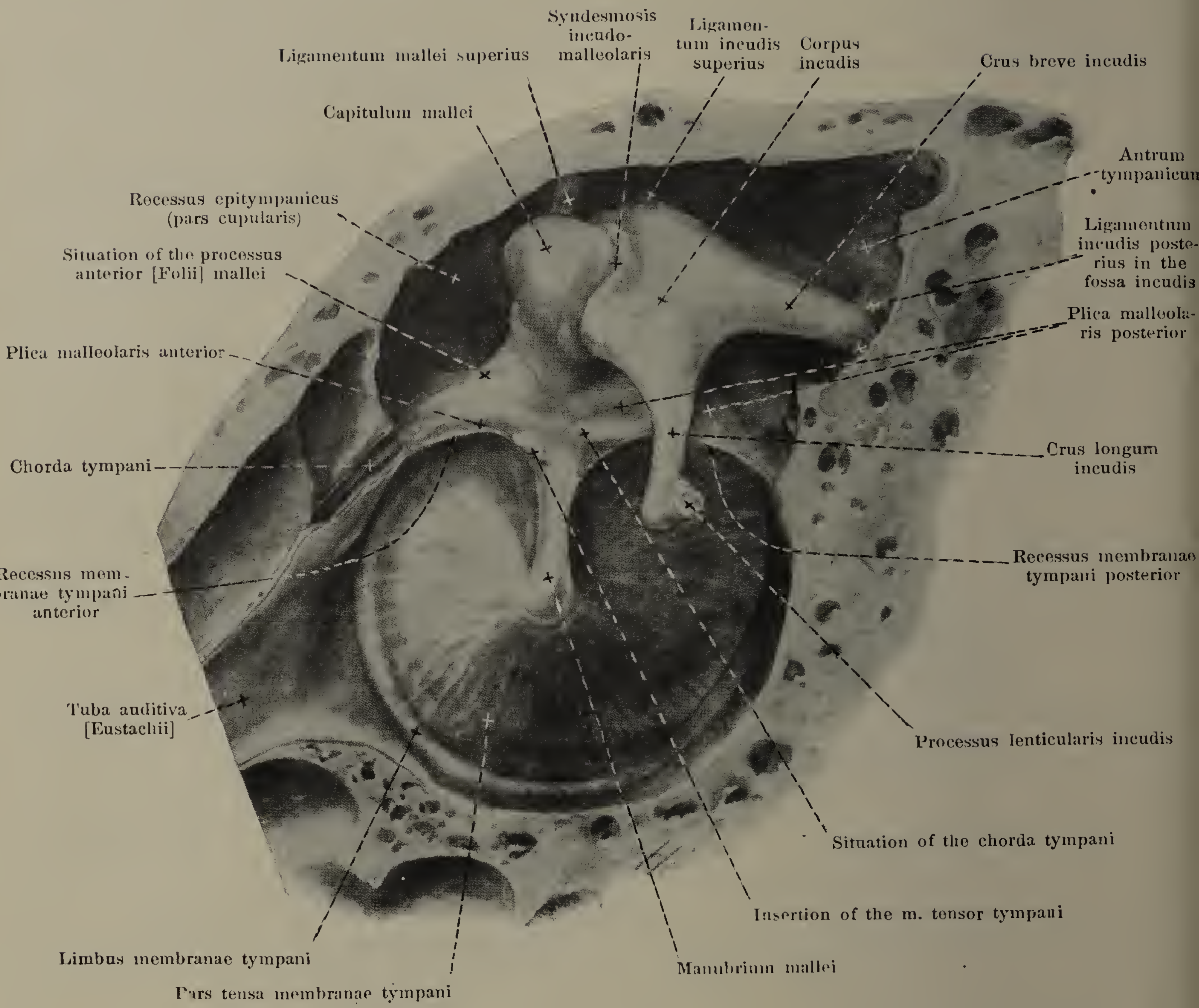
947. Right membrana tympani with the hammer and the chorda tympani, viewed from within, behind and above.

Magnification: 6:1.

(The folds of mucous membrane have been removed; the course of the chorda tympani and of the n. facialis has been exposed.)

Cavum tympani (continued).

The lateral wall (see Figs. 940—942, 946 and 948) is in large part occupied by the membrana tympani, and is therefore designated as *paries membranaceus.* It exceeds the limits of the membrana tympani below a little and in a very variable manner, considerably on the other hand above; in the latter situation it is formed by a bony plate which extends laterally over the end of the external acoustic canal, belongs to the squama temporalis and laterally bounds the *pars cupularis* of the *recessus epitympanicus* (see p. 835). In front the lateral wall goes over into the tuba auditiva, immediately above which the fissura petrotympanica [Glaseri] can be recognized in a macerated preparation.


Syndesmosis incudo-malleolaris
Ligamentum mallei superius
Ligamentum incudis superius
Corpus incudis
Crus breve incudis
Capitulum mallei
Antrum tympanicum
Recessus epitympanicus (pars cupularis)
Ligamentum incudis posterius in the fossa incudis
Situation of the processus anterior [Folii] mallei
Plica malleolaris posterior
Plica malleolaris anterior
Chorda tympani
Crus longum incudis
Recessus membranae tympani anterior
Recessus membranae tympani posterior
Tuba auditiva [Eustachii]
Processus lenticularis incudis
Situation of the chorda tympani
Insertion of the m. tensor tympani
Limbus membranae tympani
Manubrium mallei
Pars tensa membranae tympani

948. Right membrana tympani with hammer and anvil, viewed from within, behind and above. Magnification: 6:1.

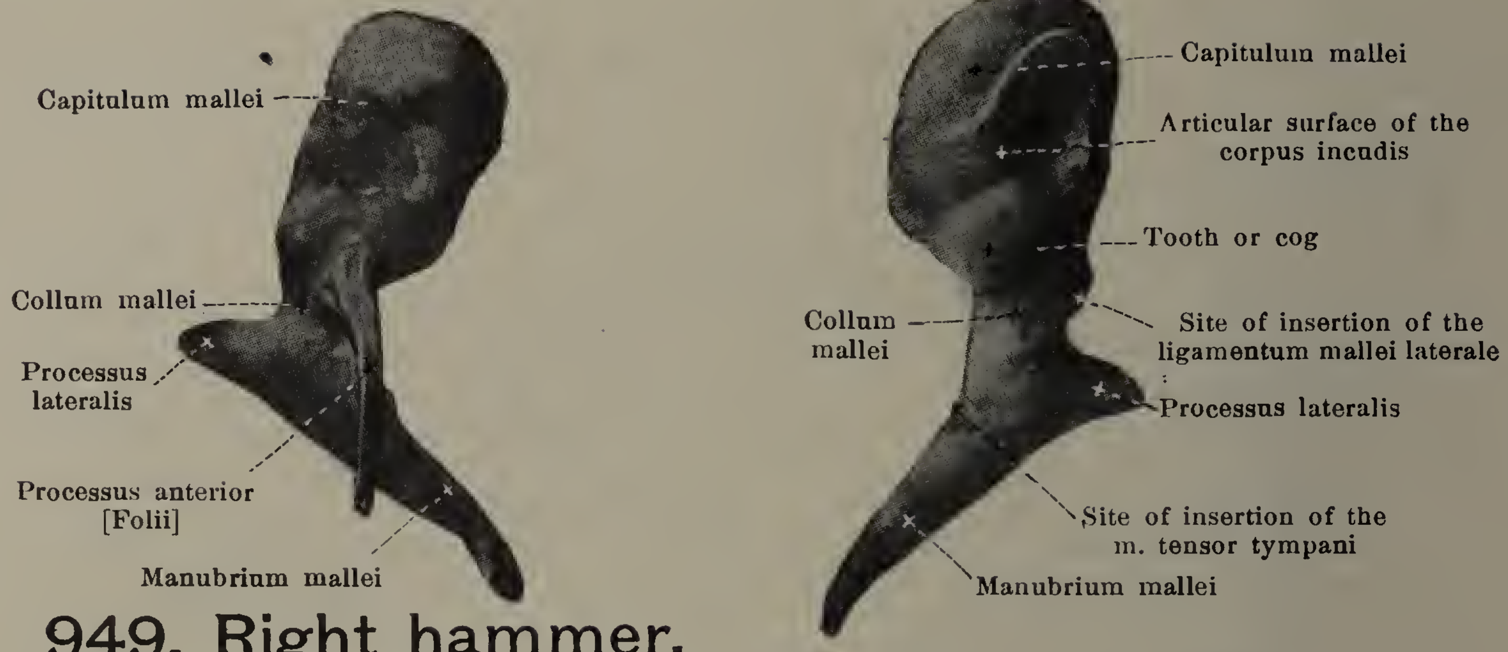
(The fold of mucous membrane, plica incudis, passing from the anvil upward and the fold running forward from the head of the hammer, the two of which bound the pars cupularis of the recessus epitympanicus medianward, are not shown in the drawing.)

Cavum tympani (see also Figs. 13, 933, 940—942 and 952) (continued): The medial wall adjoins the labyrinth and is therefore called the *paries labyrinthicus.* In the macerated bone, one notices almost in its middle a transversely oval opening, *fenestra vestibuli, vestibular window,* leading into the vestibulum, this opening being situated at the bottom of a fossa, *fossula fenestrae vestibuli* (see also Figs. 945, 952, 965—967). Medial from it and to the front, the canalis musculotubarius passes forward and the posterior end of its septum bends lateralward and forms the *processus cochleariformis.* Beneath this the *promontorium,* a large projection due to the beginning of the basal turn of the cochlea, goes forward medially without sharp limit, over into the wall of the tuba auditiva; on its surface is a groove, *sulcus promontorii,* for the reception of the plexus tympanicus [Jacobsoni]; on the upper end of the main groove at the root of the processus cochleariformis lies an opening of the canaliculus tympanicus (see p. 14). On the inferior, posterior, sharply cut-off declivity of the promontorium a triangular fossa, *fossula fenestrae cochleae,* leads forward, upward and medianward, to the *fenestra cochleae, cochlear window,* which opens into the beginning of the basal turn of the cochlea (in its scala tympani); it is bordered by a narrow bony ridge, *crista fenestrae cochleae,* to which the membrana tympani secundaria is attached.

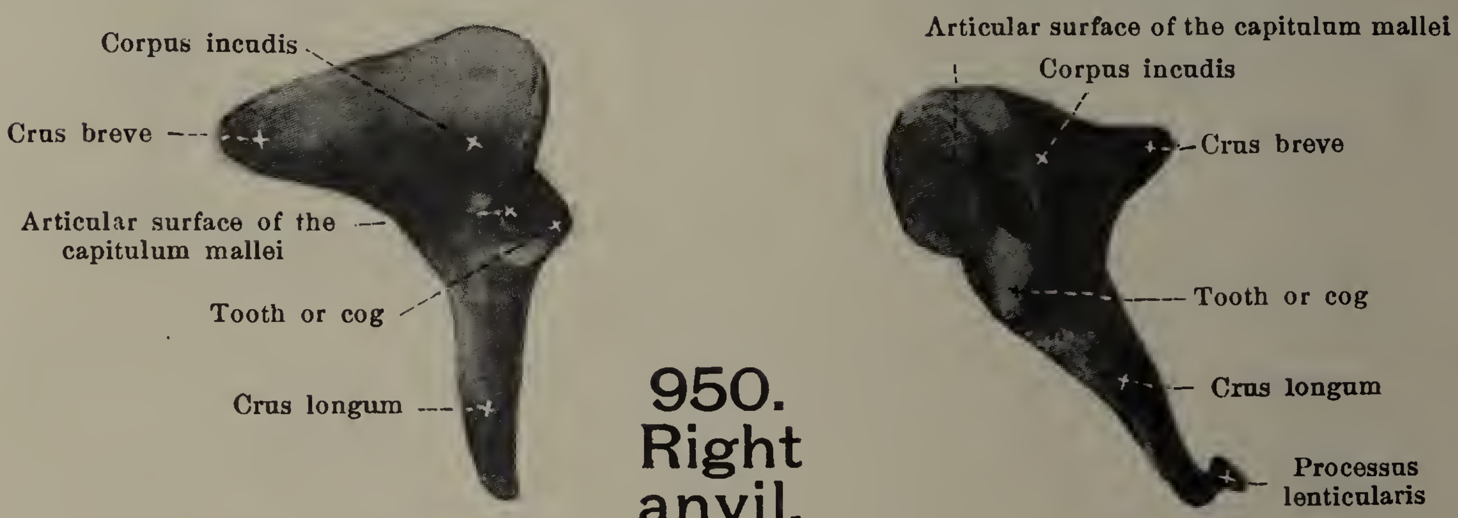
The fossula fenestrae cochleae is bounded above by a smooth bony projection, *subiculum promontorii*, which passes out dorsalward from the promontorium and forms the inferior boundary of the *sinus tympani*, a deep fossa, going over above into the fossula fenestrae vestibuli and bounded behind by the eminentia pyramidalis and the prominentia canalis facialis. Above and behind the fenestra vestibuli is the canalis facialis, passing in a curve backward and downward to vanish behind the eminentia pyramidalis. It is separated from the cavum tympani by a very thin bony leaflet which bulges the wall lateralward in the form of the *prominentia canalis facialis*. Just above it is the broad bulging of the wall due to the lateral semicircular canal and called the *prominentia canalis semicircularis lateralis*. These two bulgings form the medial boundary of the *recessus epitympanicus* (see below). The inferior wall, *paries jugularis*, goes over gradually into the anterior and posterior walls; it is sometimes smooth, sometimes studded with numerous nitches, *cellulae tympanicae*, separated by bony spicules, and contains one opening of the canaliculus tympanicus (see p. 14). At the boundary toward the posterior wall, there often projects an irregular nodule, *prominentia styloidea* (see Fig. 965), which corresponds to the upper end of the proc. styloideus. The wall abuts below partly on the fossa jugularis and varies extraordinarily in thickness. The posterior wall, *paries mastoideus*, possesses below many *cellulae tympanicae* (see above). Just near the sulcus tympanicus one sees in it a fine opening, the *apertura tympanica canaliculae chordae* (see Figs. 945, 947, 965 and 966), and at the same level, farther medianward, a small wedge-shaped elevation, *eminentia pyramidalis*. which, at its tip, possesses a small opening and in its interior an elongated cavity (see Fig. 961) for the m. stapedius; a bony spar stretched out between these two forms the lower boundary of a depression, *sinus posterior* (see Figs. 952, 962 and 965); following upon this is a step-like place in the upper deepened-cartilaginous surface of which, *fossa incudis* (see Figs. 948, 952, 962 and 965), the crus breve incudis is attached by means of the lig. incudis posterius. The portion of the tympanic cavity lying above this receives the head of the hammer and the largest part of the anvil. It is called the *recessus epitympanicus* (see Figs. 933, 940, 942, 946—948 and 952) and reaches forward and downward as far as the prominentia canalis facialis, upward as far as the tegmen tympani; concerning its lateral and median walls see p. 833 and above. Its uppermost portion, which extends downward between the lateral wall on one side, the capitulum mallei, corpus and crus breve incudis and the folds of mucous membrane stretched out from them to the upper and anterior walls on the other side (see also p. 839) ends below in the form of a blind sack, called the *pars cupularis* (see Fig. 948), over the lig. mallei anterius. The recessus epitympanicus is directly continuous behind with the *antrum tympanicum*, a larger cavity roofed in above by the tegmen tympani; it forms the entrance to the very variable *cellulae mastoideae* (see also p. 11). The upper wall of the tympanic cavity, *paries tegmentalis* (see Figs. 952 and 966), is formed by the tegmen tympani (see p. 13) and is slightly rough. The anterior wall, *paries caroticus* (see Fig. 952), is bony only in its lower portion, where it possesses *cellulae tympanicae* and the openings of the canaliculi caroticotympanici (see p. 15). It is formed by a bony leaflet of variable thickness which separate it from the ascending part of the canalis caroticus (see Figs. 831, 940, 941 and 961). Its upper part is occupied by the *ostium tympanicum tubae auditivae.*

Ossicula auditus, small bones of the ear (see Figs. 933, 940—952), lie in the upper part of the tympanic cavity, are articulated with one another and form a chain which begins in the membrana tympani and ends in the fenestra vestibuli. They show considerable individual variations. (Development see p. 68.)

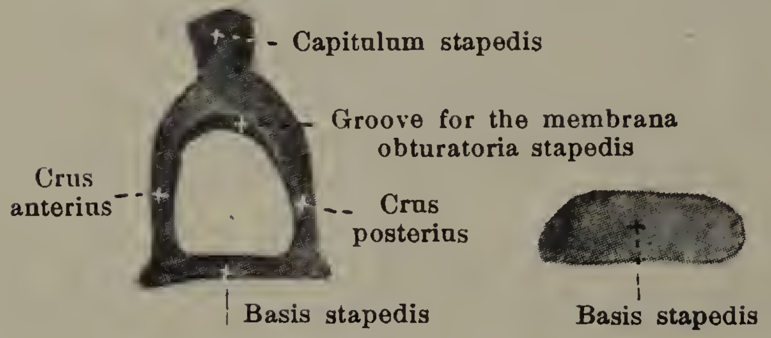
1. *Malleus, hammer* (see Figs. 933, 942—949), the largest of them, lies farthest lateral and forward. Its upper part, *capitulum mallei, head of hammer*, situated in the recessus epitympanicus, is thick and club-shaped and presents on its posterior and medial surfaces an elongated approximately saddle-shaped articular surface for the corpus incudis, which encroaches below upon a toothlike process, *tooth* or *cog of the hammer*. The head is separated by a constriction, *collum mallei, neck of the hammer*, from the *manubrium mallei, handle of the hammer;* the latter is a thin, bony rod, oval in cross-section, which tapers off toward the tip, where it ends like a spatula; its largest cross-section plane is perpendicular to the plane of the membrana tympani with the middle plate of which the handle of the hammer is fixed; on its lateral margin it has a cartilaginous covering; its lateral surface gives rise to the stria malleolaris (see p. 829) and internally it is covered by the mucous membrane of the tympanic cavity. With the head of the hammer, the handle forms an angle varying according to race, age and individual (on the average of about 130°) being always somewhat greater on the right than on the left. Its angle with the horizontal plane varies also, and amounts on the average on the right to about 50°, on the left to 45°. Above and laterally the handle of the hammer is continued into the small, tapered *processus lateralis*, which bulges out the prominentia malleolaris of the tympanic membrane. From the anterior surface of the neck, there passes forward the thin *processus anterior [Folii]* which appears longer in the infant.


Capitulum mallei
Collum mallei
Processus lateralis
Processus anterior [Folii]
Manubrium mallei
Capitulum mallei
Articular surface of the corpus incudis
Tooth or cog
Collum mallei
Site of insertion of the ligamentum mallei laterale
Processus lateralis
Site of insertion of the m. tensor tympani
Manubrium mallei

949. Right hammer,
viewed from in front. Magn.: 6:1. viewed from behind.



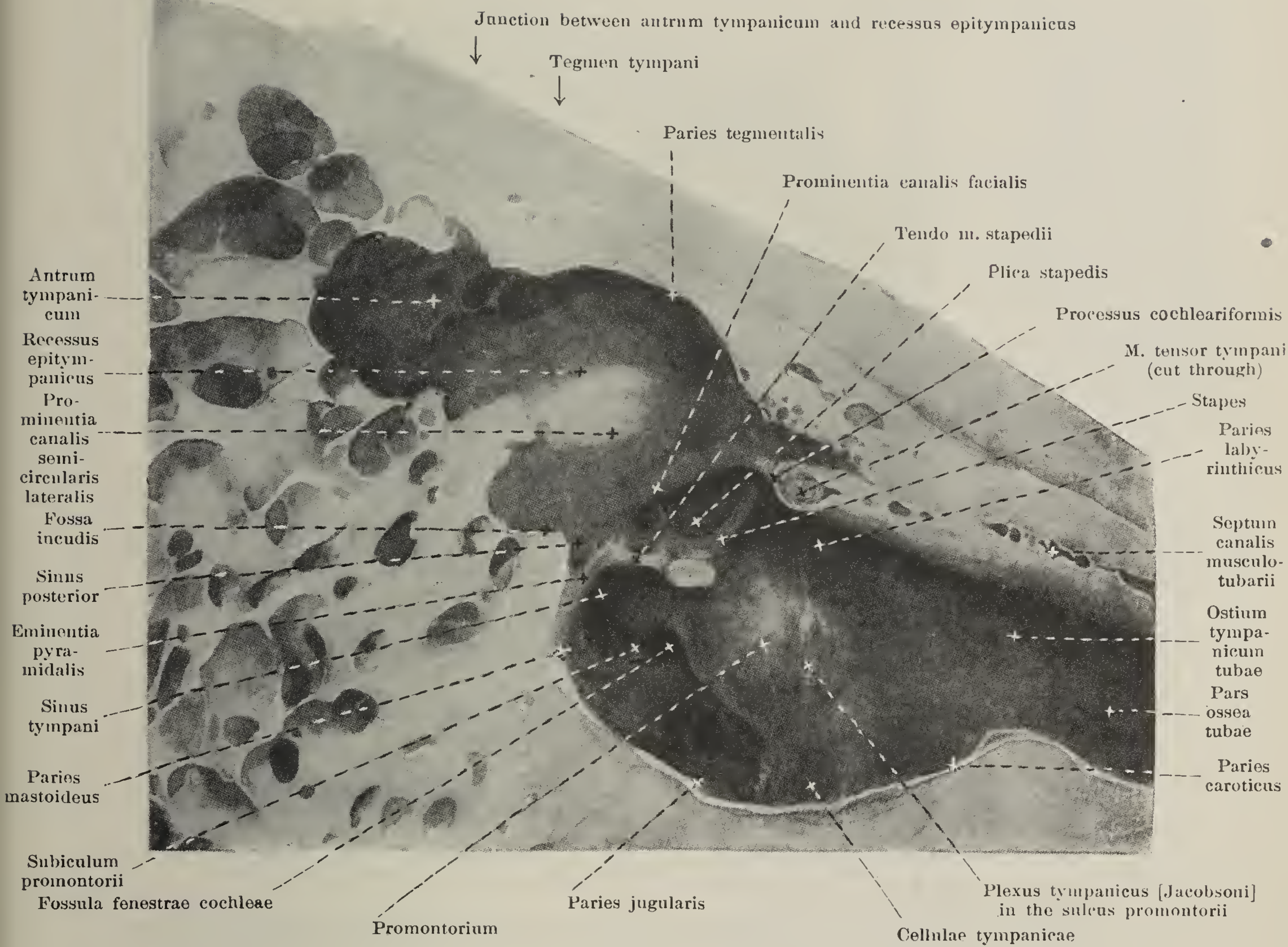
950. Right anvil,
lateral view. Magn.: 6:1. medial and front view.



951. Right stirrup,
viewed from above. Magn.: 6:1. medial view.

2. ***Incus, anvil*** (see also Figs. 942, 945 and 948), has approximately the form of a tooth with two roots. To the crown of the tooth corresponds the flattened *body, corpus incudis;* on its free basis it presents a saddle-shaped articular surface which encroaches somewhat upon a ridge on the lateral surface, the *tooth* or *cog of the anvil,* and serves for the reception of the head of the hammer. To the roots of the tooth correspond the *crus breve* and *crus longum, short* and *long leg;* the short leg is thicker and plumper; both taper out toward their tips and diverge from one another forming an angle of about 100°. The short leg is directed horizontally backward; its tip is covered with cartilage and lies in the fossa incudis (see p. 835). The long one runs parallel to the manubrium mallei and lies somewhat medially and dorsally from it. On the medial side of the tip of the long leg is a small process, *processus lenticularis.*

3. *Stapes, stirrup* (see also Figs. 942, 944 and 952), possesses a *foot-plate, basis stapedis,* two *legs, crus anterius* and *posterius;* and a *small head, capitulum stapedis.* The foot-plate fills up the fenestra vestibuli nearly completely, is flat and possesses an upper, convex and a lower, straight or slightly concave margin. The two legs are hollowed out groove-like on their concave side, and are of approximately equal length; the anterior is finer than the posterior and less markedly curved; the latter possesses near its capitulum a small rough area for the insertion of the m. stapedius. Between the legs and the foot plate is stretched out a thin connective tissue membrane, *membrana obturatoria stapedis* (not illustrated). The capitulum is very variable and presents on its lateral free end a small articular surface covered with cartilage for the processus lenticularis. The plane of the stirrup lies approximately horizontally and is laterally inclined somewhat downward (see Fig. 952).



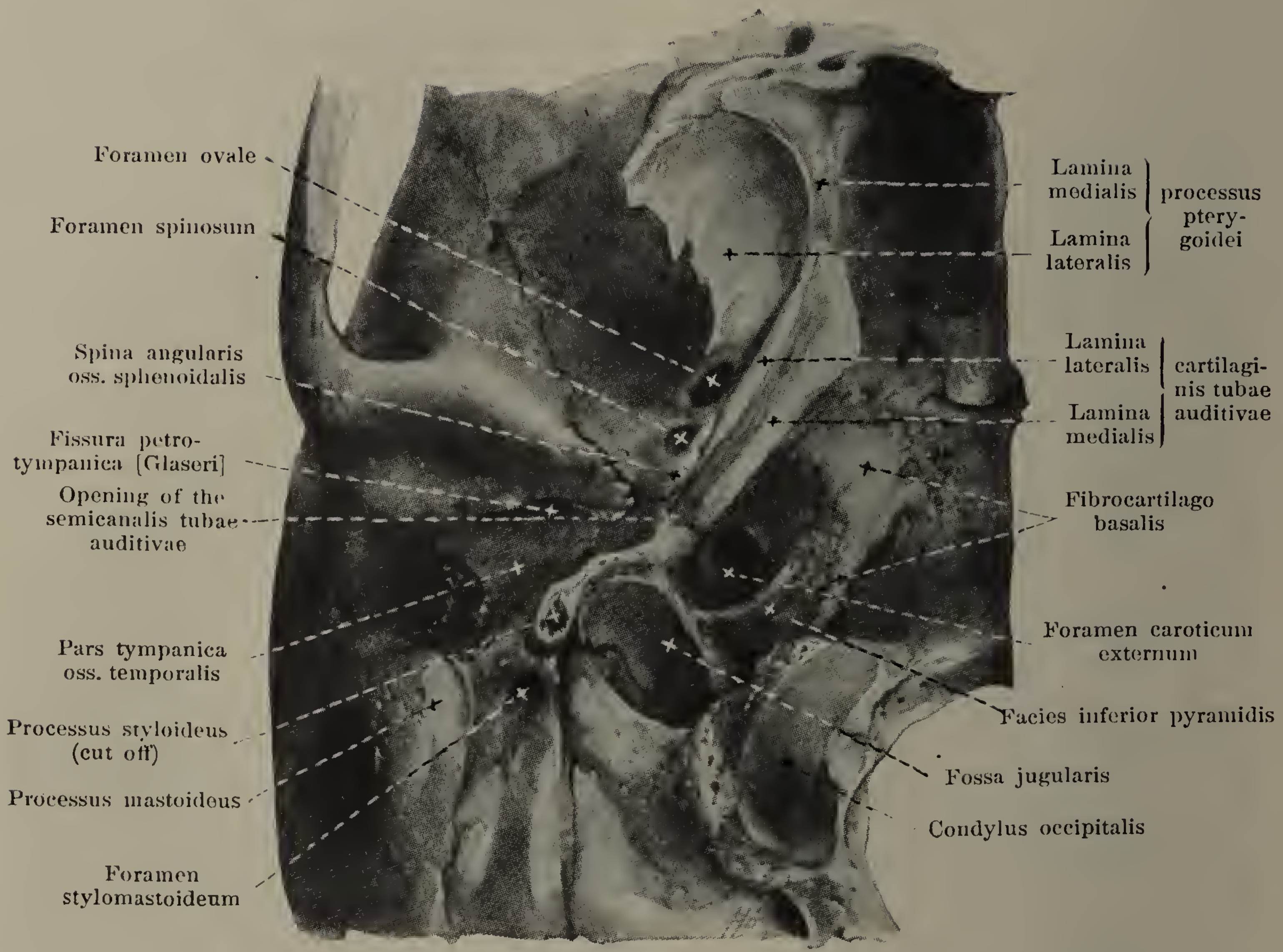
952. Medial wall of the right tympanic cavity,

lateral view. Magnification: 5:1.

The small bones of the ear are united with one another by joints, *articulationes ossiculorum auditus,* namely by the *syndesmosis incudomalleolaris* (see Fig. 948) between the head of the hammer and the body of the anvil, the *articulatio incudostapedia* between the processus lenticularis of the anvil and the capitulum stapedis and the *syndesmosis tympanostapedia* between the cartilage-covered margins of the fenestra vestibuli and the basis stapedis, the interspace of which is filled up by a ligamentous mass, *lig. annulare basis stapedis* (not illustrated).

The small bones of the ear are fastened in the wall of the tympanic cavity so that the manubrium mallei is inserted in the membrana tympani and the basis stapedis is fastened in the fenestra vestibuli; in addition there are interosseous ligaments, *ligamenta ossiculorum auditus:*

1. *Lig. mallei anterius* (see Figs. 945 and 947), in the plica malleolaris anterior, from the proc. anterior [Folii] mallei, ensheathing it; it passes into the fissura petrotympanica [Glaseri] and goes on as far as the spina angularis of the sphenoid bone.
2. *Lig. mallei laterale* (see Fig. 942), diverging from the neck of the hammer to the spinae tympanicae major and minor and to the margin of the incisura tympanica [Rivini].
3. *Lig. mallei superius* (see Figs. 942, 947 and 948), variable, from the roof of the recessus epitympanicus downward to the upper end of the head of the hammer.
4. *Lig. incudis posterius* (see Fig. 948) passes from the crus breve incudis to the posterior wall of the tympanic cavity and fastens the former in the fossa incudis.
5. *Lig. incudis superius* (see Fig. 948) from the roof of the recessus epitympanicus downward to the corpus incudis; it is only a bridge of mucous membrane and contains no ligamentous fibres.


Foramen ovale
Foramen spinosum
Spina angularis oss. sphenoidalis
Fissura petrotympanica [Glaseri]
Opening of the semicanalis tubae auditivae
Pars tympanica oss. temporalis
Processus styloideus (cut off)
Processus mastoideus
Foramen stylomastoideum
Lamina medialis
Lamina lateralis
processus pterygoidei
Lamina lateralis
Lamina medialis
cartilaginis tubae auditivae
Fibrocartilago basalis
Foramen caroticum externum
Facies inferior pyramidis
Fossa jugularis
Condylus occipitalis

953. Cartilage of the right Eustachian tube,
viewed from below.

(The processus styloideus has been cut off at its root.)

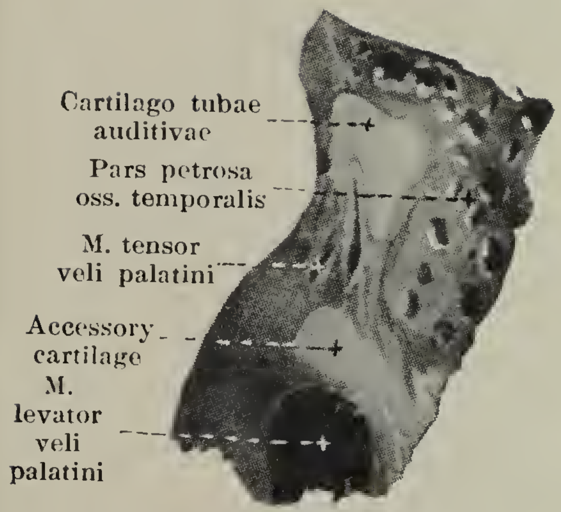
Musculi ossiculorum auditus.

1. *M. tensor tympani* (see Figs. 933, 942, 945—948 and 952), spindle-shaped, bipinnate lies in the semicanalis m. tensoris tympani (see p. 13) the bony wall of which is completed by a tough connective membrane. It arises from the upper surface of the cartilago tubae auditivae and from the walls of the canal (especially the upper). The rounded tendon bends around, almost at a right angle, at the proc. cochleariformis, passes lateralward through the tympanic cavity, covered by mucous membrane, and becomes attached to the handle of the hammer near the neck of the hammer. It draws the manubrium mallei medianward and stretches the membrana tympani. Innervation: n. tensoris tympani (V).

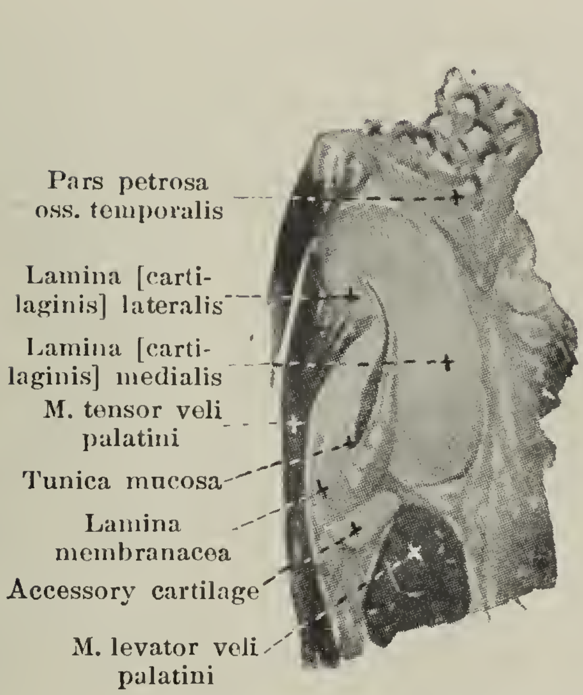
2. *M. stapedius* (see Figs. 831, 945 and 952), pinnate, fills up the cavity situated in the eminentia pyramidalis (see Fig. 961). Its tendon appears at the tip of the eminentia pyramidalis, bends somewhat downward at an obtuse angle and, covered by mucous membrane, passes forward and medianward to the posterior margin of the capitulum stapedis. It moves the posterior end of the basis stapedis somewhat inward, the anterior end more strongly outward. Innervation: *n. stapedius* (VII).

Tunica mucosa tympani, mucous membrane of the tympanic cavity (see Figs. 942, 946, 948 and 952), lines the surface of the whole tympanic cavity, of the cellulae mastoideae, of the small bones of the ear, of the membrana tympani (see p. 831), as well as of the tendons and ligaments, as a thin membrane and is intimately united with the periosteum. In approaching some of these structures, duplicatures or *folds, plicae,* are formed, most of which are very variable.

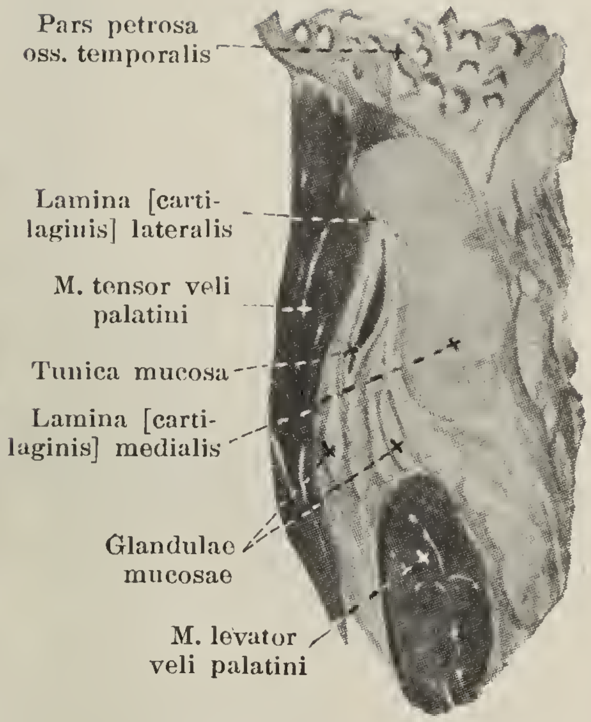
The most constant folds are the following: the *anterior hammer fold, plica malleolaris anterior* (see Figs. 946—948), goes off from the membrana tympani between the spina tympanica major and the manubrium mallei, ensheaths the proc. anterior [Folii] mallei, the lig. mallei anterius, and the anterior part of the chorda tympani, and ends in a free concave margin; the pocket ending blind above, situated between it and the membrana tympani, is called the *anterior pocket of the membrana tympani, recessus membranae tympani anterior.* The larger, *posterior hammer fold, plica malleolaris posterior* (see Fig. 948), goes off from the membrana tympani between the spina tympanica minor and the manubrium mallei, is fastened behind to the uppermost part of the sulcus tympanicus, encloses below the posterior part of the chorda tympani and ends with a free concave margin.



954. Near the lateral end of the cartilaginous part.



955. At the junction between the lateral and middle thirds.

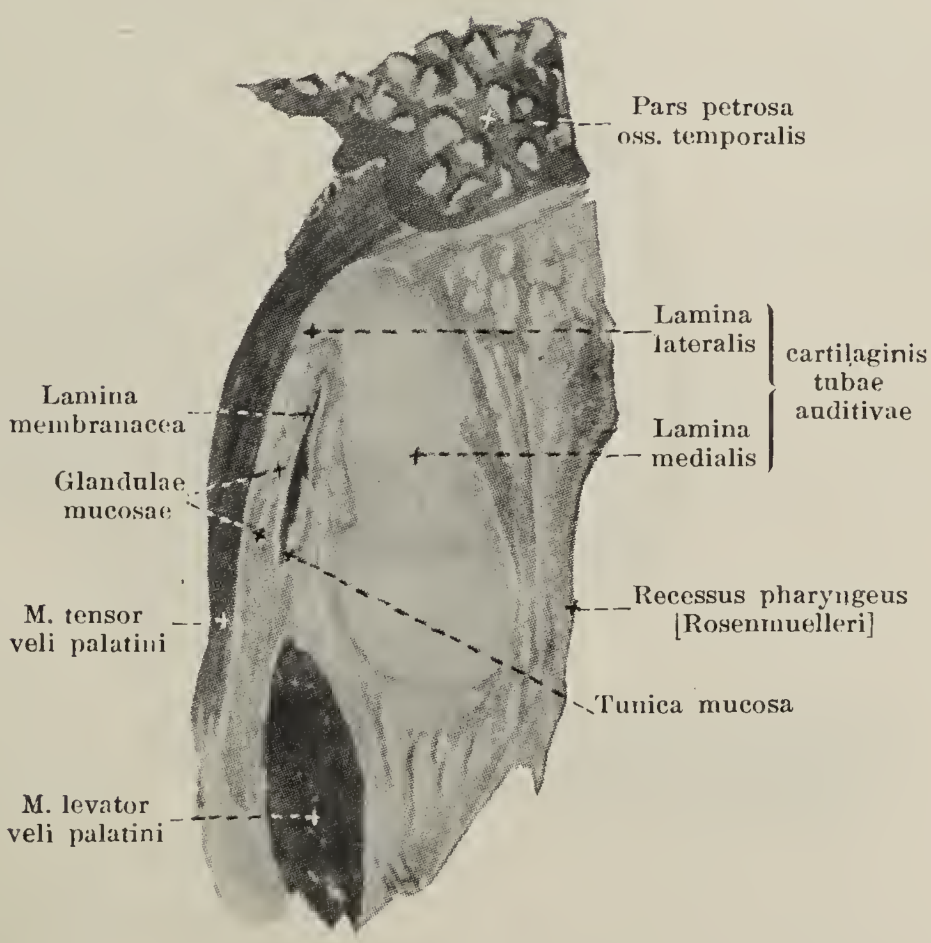

Pars petrosa oss. temporalis
Lamina [cartilaginis] lateralis
M. tensor veli palatini
Tunica mucosa
Lamina [cartilaginis] medialis
Glandulae mucosae
M. levator veli palatini

956. At the junction between the middle and medial thirds.

954—957. Cross-sections through the cartilaginous Eustachian tube of the right side,

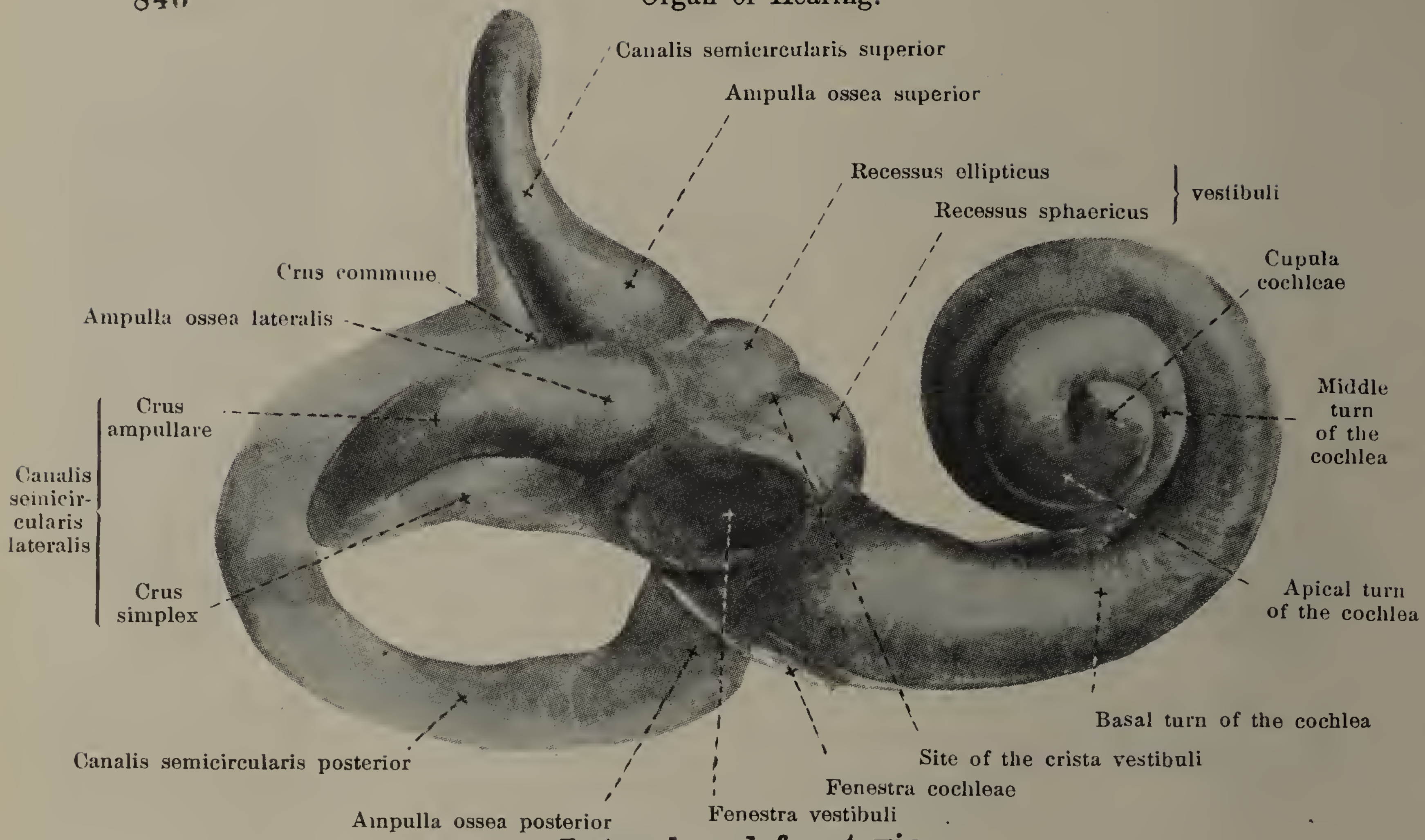
viewed from the medial side.

Magnification: 3 : 1.

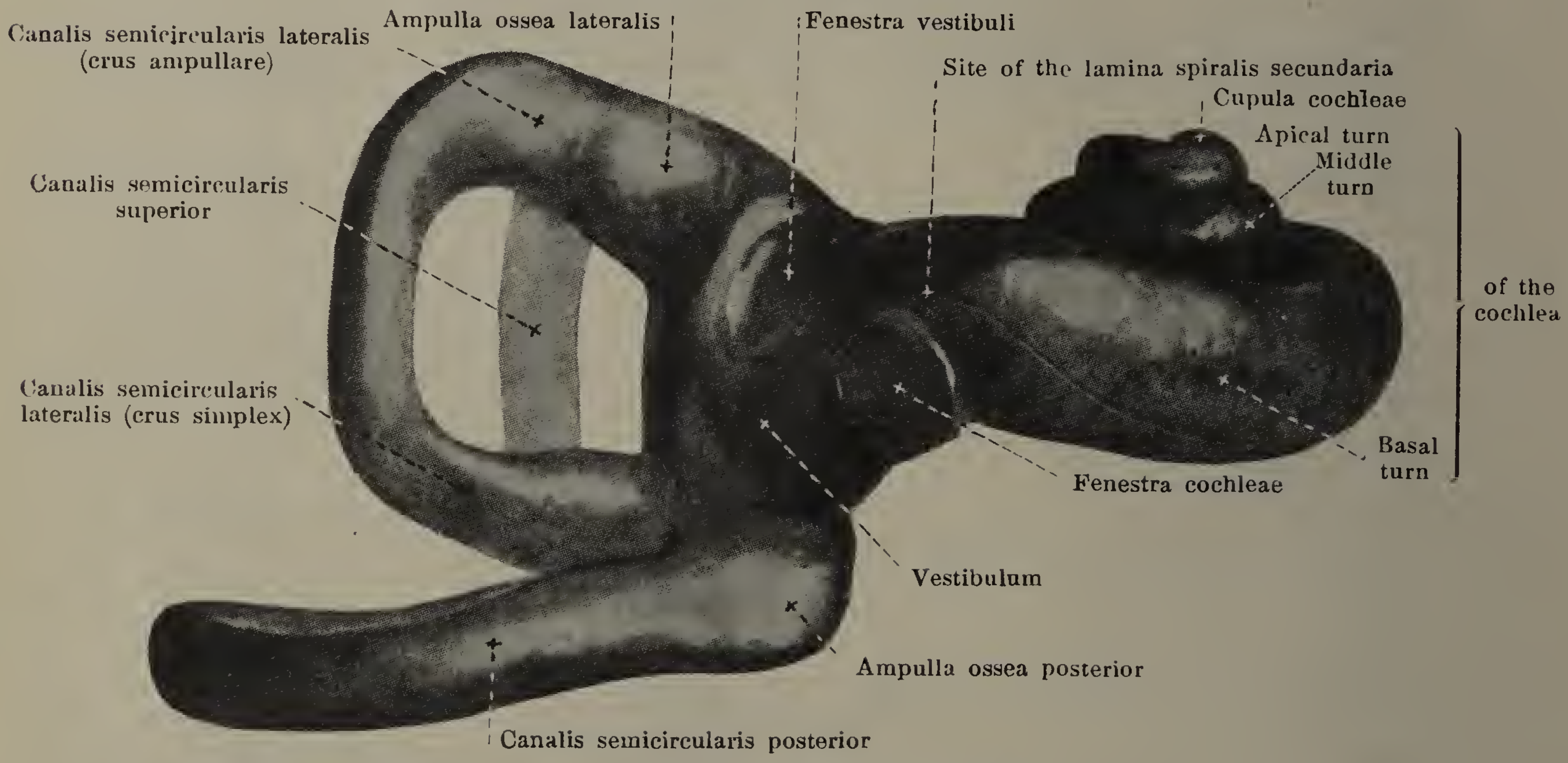


957. Near the ostium pharyngeum tubae auditivae.

Tunica mucosa tympani (continued) (see Figs. 942, 948 and 952). Between the posterior hammer fold and the membrana tympani lies the *posterior pocket of the membrana tympani*, *recessus membranae tympani posterior.* It ends blind above or is continued above directly into the *upper pocket of the membrana tympani, recessus membranae tympani superior* (see Fig. 942), enclosed by the pars flaccida of the membrana tympani, the lig. mallei laterale as well as the collum and proc. lateralis mallei; the pocket may also open inward through a special foramen. From the roof of the recessus epitympanicus a vertical fold, *plica incudis* (not illustrated), descends to the corpus and crus breve incudis and a similar fold goes from the head of the hammer to the anterior wall; they help to form the medial wall of the pars cupularis of the recessus epitympanicus (see p. 835). The *plica stapedis* (see Fig. 952) ensheaths the whole stirrup along with the membrana obturatoria stapedis and the tendon of the m. stapedius and often stretches out also to the posterior wall of the tympanic cavity. Over the fenestra cochleae the mucous membrane, as it passes, helps to form the *membrana tympani secundaria* (see p. 854).



Lateral and front view.

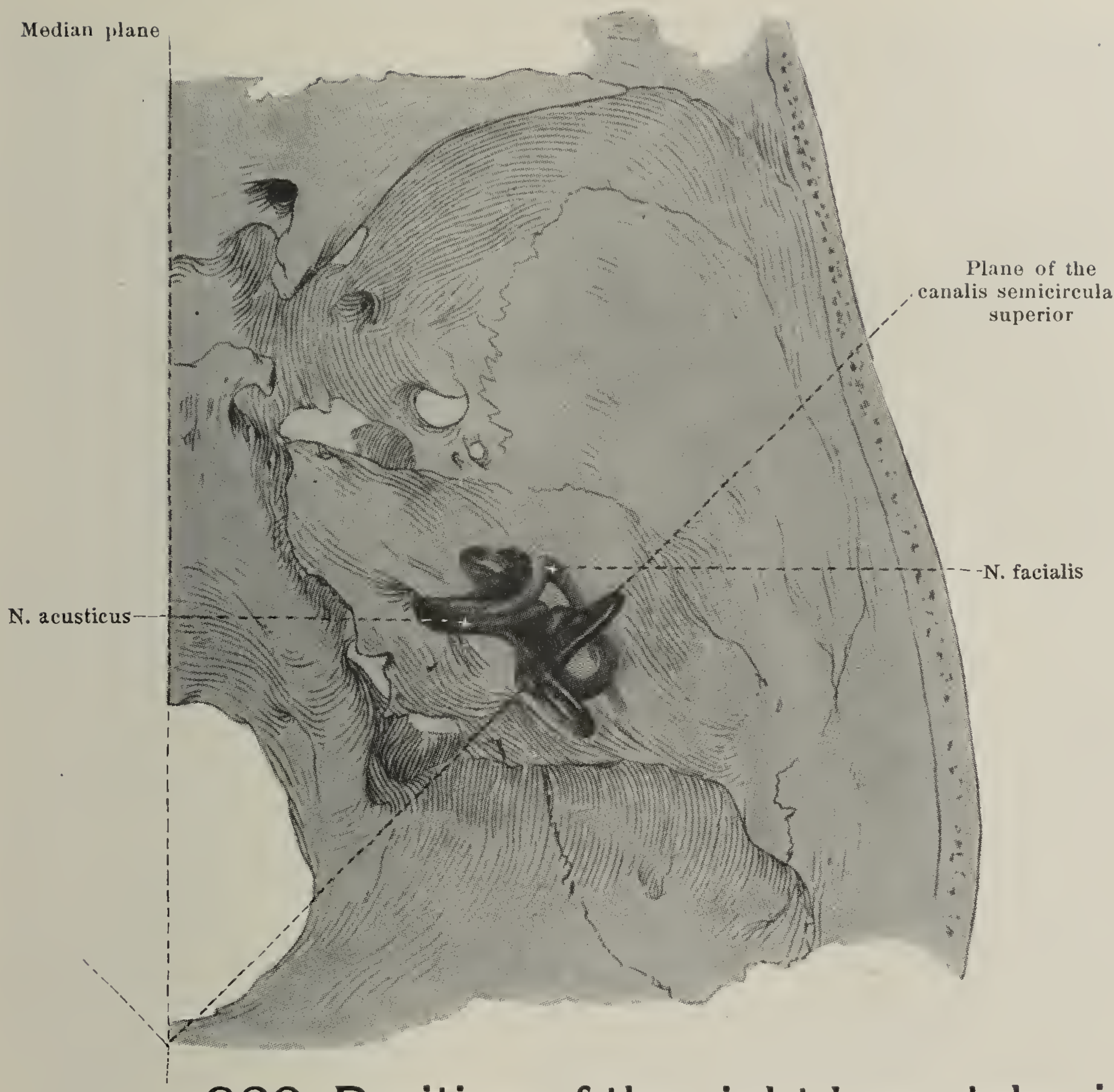

Canalis semicircularis lateralis (crus ampullare)
Ampulla ossea lateralis
Fenestra vestibuli
Site of the lamina spiralis secundaria
Cupula cochleae
Apical turn
Middle turn
of the cochlea
Basal turn
Canalis semicircularis superior
Canalis semicircularis lateralis (crus simplex)
Fenestra cochleae
Vestibulum
Ampulla ossea posterior
Canalis semicircularis posterior

Viewed from below.

958 and 959. Corrosion preparation of the right bony labyrinth of the ear. Magnification: 6 : 1.

Tuba auditiva [Eustachii], ear trumpet, Eustachian tube (see Figs. 596, 600—604 933, 941, 942, 948 and 952—957), unites the tympanic cavity with the pharynx, runs in general obliquely forward medially and downward and divides into a lateral shorter bony part and a medial longer cartilaginous part. These form with one another a large obtuse angle open below, the vertex of which corresponds to the narrowest part of the lumen, the *isthmus tubae auditivae.*

The bony part, *pars ossea tubae auditivae,* begins in the anterior wall of the tympanic cavity (see p. 835) with the oblong-oval *ostium tympanicum tubae auditivae* and includes the semicanalis tubae auditivae (see p. 13). Its lumen narrows medianward and is approximately triangular; the upper wall is formed by the tegmen tympani.

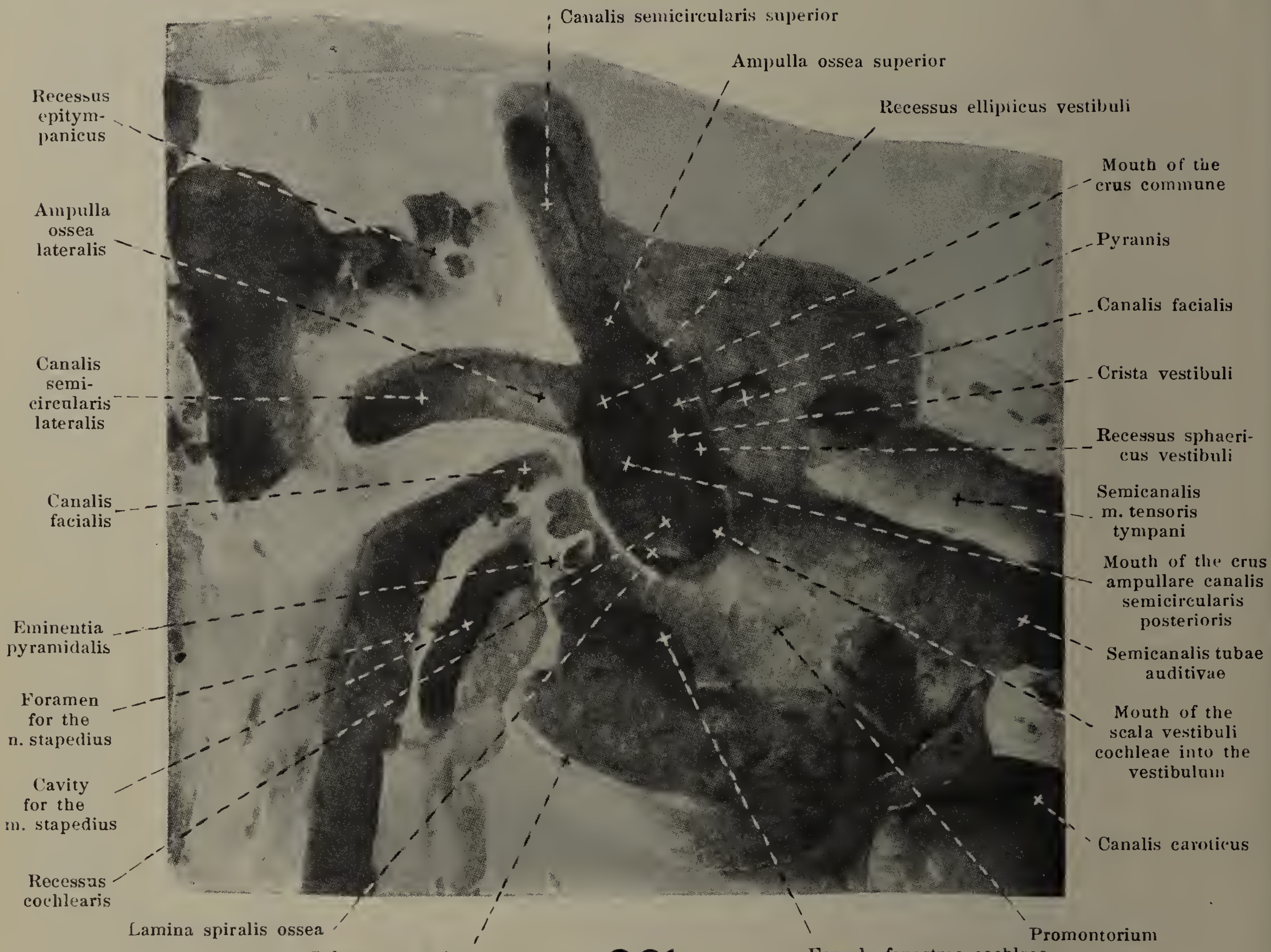


960. Position of the right bony labyrinth of the ear in the skull, viewed from above.

(The temporal bone is considered transparent and the labyrinth drawn in from a corrosion preparation.)

Tuba auditiva (continued) (see Figs. 596, 600—604, 933, 941, 942, 948 and 952—957). The medial wall of the bony part is formed partly by the septum canalis musculotubarii and its connective tissue supplement (see p. 838), partly by the continuation of the medial wall of the tympanic cavity and lies laterally very close to the canalis caroticus (see also Fig. 968). The lateral wall is shorter than the others and consists of the pars tympanica of the temporal bone; the lower boundary is groove-like and near the tympanic cavity presents several variably developed small evaginations, *cellulae pneumaticae tubarii.*

The cartilaginous part, *pars cartilaginea tubae auditivae,* reaches as far as the *ostium pharyngeum tubae auditivae* (see p. 523), its form being essentially determined by the *cartilago tubae auditivae* which consists partly of hyaline, partly of elastic cartilage. This together with the broad plate, *lamina [cartilaginis] medialis,* which is somewhat thickened below, forms the whole posterior, medial wall, and together with the narrow, upper continuation of the former, bent around sharply downward, the *lamina [cartilaginis] lateralis,* forms the upper part of the anterior, lateral wall; the cartilage directly adjoins the bone of the pars ossea and laterally is somewhat longer, since there the bone stops sooner (vide supra). The upper edge of the cartilage is united firmly along and under the fissura sphenopetrosa with the fibrocartilago basalis, the lateral plate adjoins laterally the sulcus tubae auditivae oss. sphenoidalis and medially the posterior margin of the proc. pterygoideus. The lateral wall is formed beneath the lamina lateralis by the fibrous *lamina membranacea.* From it and the lamina lateralis arise fibres of the m. tensor veli palatini (see p. 524). The whole inner surface of the Eustachian tube is lined by mucous membrane, *tunica mucosa.* This is very thin in the bony part; in the cartilaginous part it is thicker and contains numerous mucous glands, *glandulae mucosae,* and various lymph nodules, *noduli lymphatici tubarii.* The lumen of the cartilaginous part is slit-like and in the middle of its length is closed when the velum palatinum is loose.


Canalis semicircularis superior
Ampulla ossea superior
Recessus ellipticus vestibuli
Recessus epitympanicus
Mouth of the crus commune
Ampulla ossea lateralis
Pyramis
Canalis facialis
Canalis semicircularis lateralis
Crista vestibuli
Recessus sphaericus vestibuli
Canalis facialis
Semicanalis m. tensoris tympani
Mouth of the crus ampullare canalis semicircularis posterioris
Eminentia pyramidalis
Semicanalis tubae auditivae
Foramen for the n. stapedius
Mouth of the scala vestibuli cochleae into the vestibulum
Cavity for the m. stapedius
Canalis caroticus
Recessus cochlearis
Lamina spiralis ossea
Promontorium
Sulcus tympanicus
Fossula fenestrae cochleae

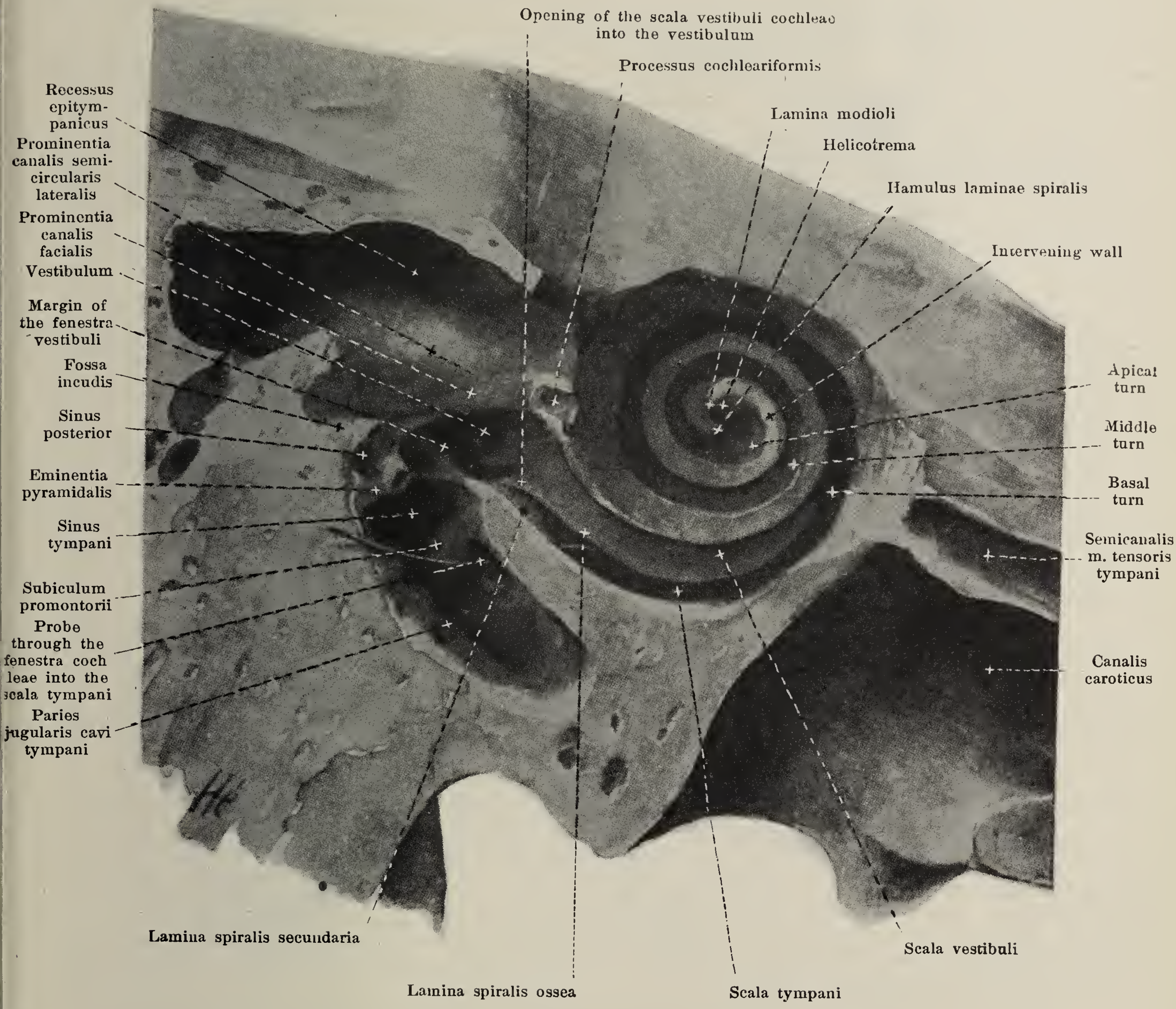
961.

Right vestibule and semicircular canals in the macerated bone, open from the outside. Magn.: 5 : 1.

(In addition the canales caroticus and facialis, as well as the cavity for the m. stapedius have been opened up.)

Auris interna, *internal ear*, consists of a hollow space in the bone, the *bony labyrinth*, *labyrinthus osseus*, and the *membranous labyrinth*, *labyrinthus membranaceus*, surrounded by it.

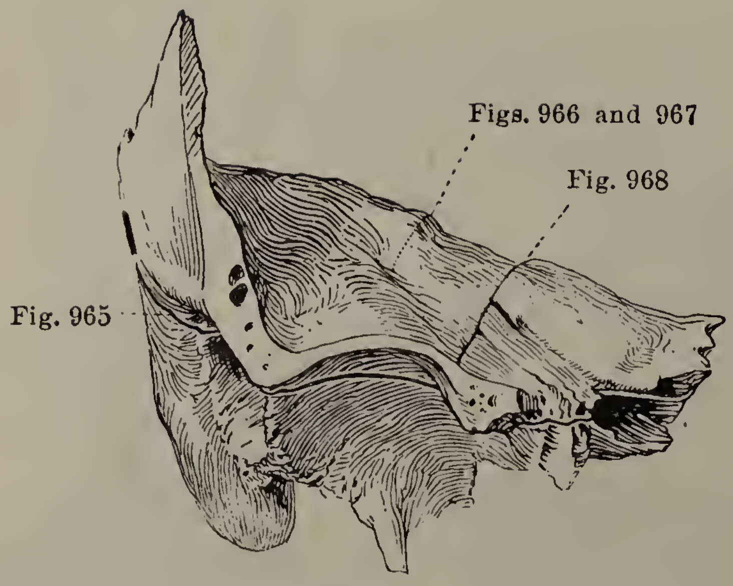
Labyrinthus osseus, *bony labyrinth* (see also Figs. 958—960 and 962—970), lies within the pars petrosa oss. temporalis, lateralward adjoins the paries labyrinthicus of the tympanic cavity, medianward the floor of the meatus acusticus internus, being connected through the latter with the skull cavity. It is surrounded by a very hard layer of bone, 2—3 mm thick, the *bony labyrinthine capsule* (see Figs. 965 and 968), which in the fetus and new-born in many places reaches the surface of the pars petrosa, in others is separated by spongy bony substance distinctly from the rest of the bony mass of the pyramid of the temporal bone, while in the adult it lies more in the interior and is in large part fused with the compact bony substance of the neighborhood. The bony labyrinth is almost as large in the new-born as in the adult. It surrounds a system of cavities in which three parts may be distinguished: a middle, the *vestibule*, a medial, anterior, the *cochlea*, and a lateral, posterior, the three *semicircular canals*. The *bony labyrinth* has a maximal length of about 20 mm and lies approximately parallel to the posterior surface of the pyramid of the temporal bone; thus situated the cochlea lies in front medially and below, the semicircular canals behind laterally and above. The basis of the cochlea adjoining the meatus acusticus internus is directed parallel to the plane of the posterior semicircular canal; both run approximately vertically and form an angle of 45° with the median plane, as does the plane of the superior semicircular canal which stands perpendicular to both; the meatus acusticus internus is directed nearly horizontally and frontally.


Opening of the scala vestibuli cochleae into the vestibulum
Processus cochleariformis
Lamina modioli
Helicotrema
Hamulus laminae spiralis
Intervening wall
Recessus epitympanicus
Prominentia canalis semicircularis lateralis
Prominentia canalis facialis
Vestibulum
Margin of the fenestra vestibuli
Fossa incudis
Sinus posterior
Eminentia pyramidalis
Sinus tympani
Subiculum promontorii
Probe through the fenestra cochleae into the scala tympani
Paries jugularis cavi tympani
Apical turn
Middle turn
Basal turn
Semicanalis m. tensoris tympani
Canalis caroticus
Lamina spiralis secundaria
Lamina spiralis ossea
Scala tympani
Scala vestibuli

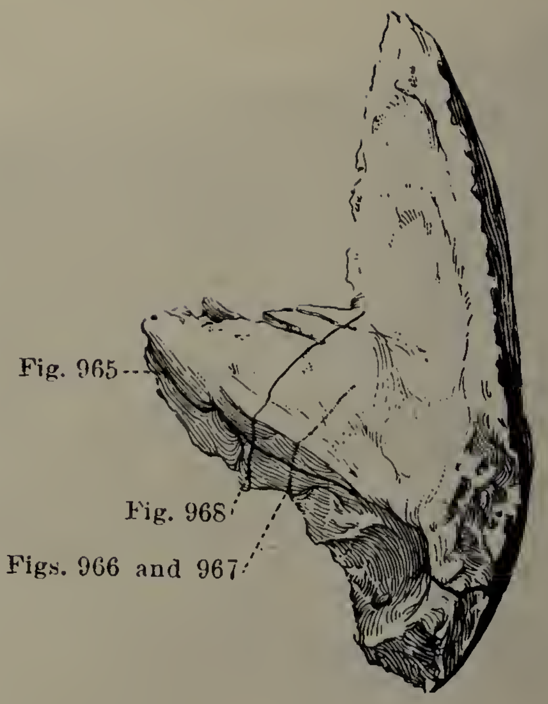
962. Right cochlea in the macerated bone open from the outside. Magnification: 5:1.

(The canalis caroticus has been laid open; a fine probe has been passed through the fenestra cochleae.)

The *vestibule, vestibulum* (see Figs. 958, 959, 961 and 965—967), is a small oval cavity, the wall of which is almost everywhere smooth. Its medial wall (see Figs. 961, 965 and 967) helps in its anterior part at the same time to form the fundus meatus acustici interni, namely the part of the same occupied by the areae vestibulares. On it (see Fig. 967) runs a delicate ridge, *crista vestibuli*, which begins laterally over the fenestra vestibuli, runs at first obliquely backward and downward, but then straight downward and marks off from one another two deepened areas of unequal size. The posterior, superior elongated oval area, *recessus ellipticus,* serves for the reception of the utriculus (see p. 851) and contains in a small depression the *apertura interna aquaeductus vestibuli* (see p. 11). The anterior, inferior rounded area, *recessus sphaericus,* receives the sacculus (see p. 852) and in its middle contains a small, perforated area, *macula cribrosa media*, in which open the fine foramina of the area vestibularis inferior (see p. 850) and the n. saccularis (see p. 728) arrives in the vestibule.



963. Right temporal bone, viewed from in front and above, after removal of the anterior part of the squama temporalis,



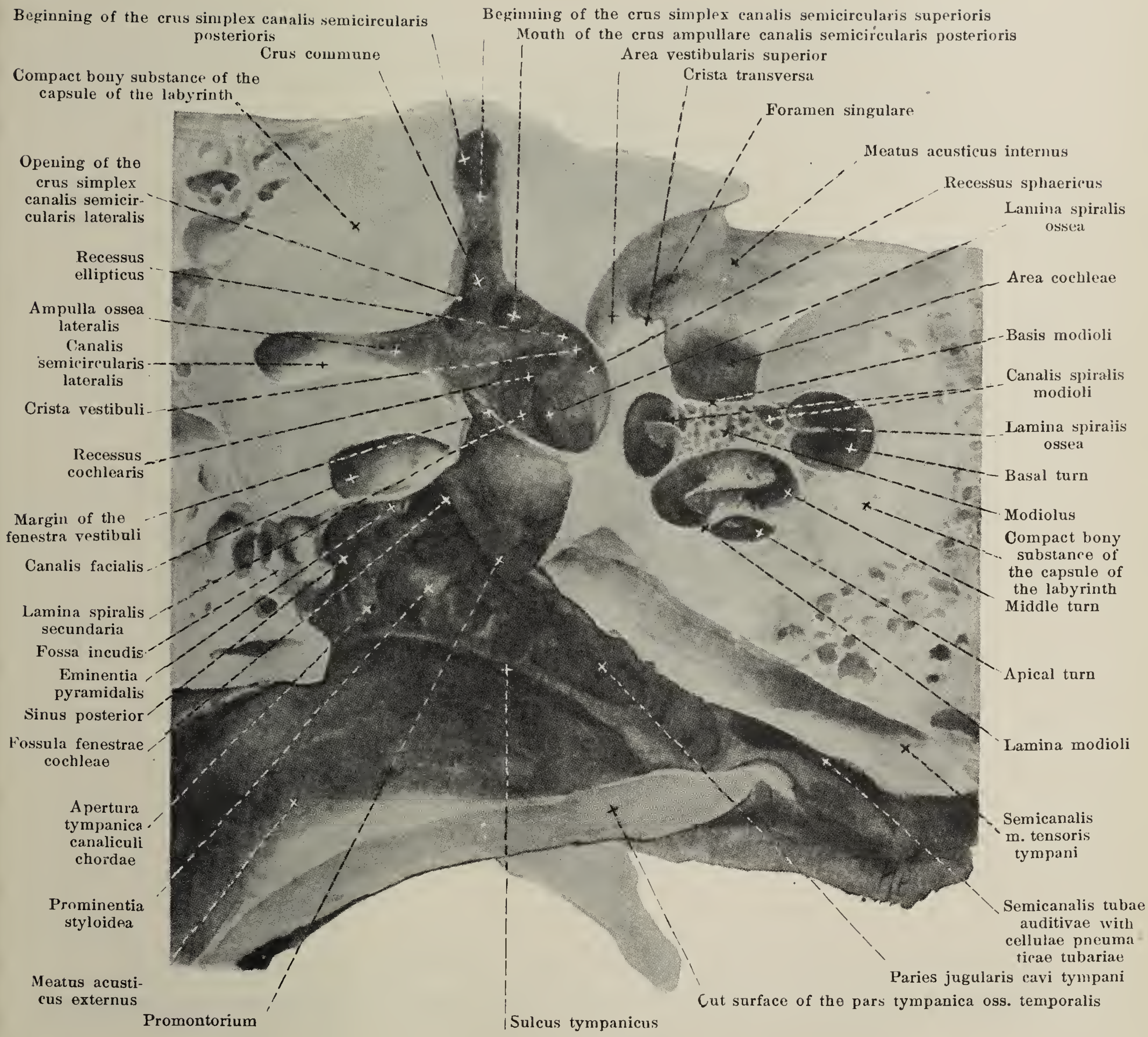
964. Right temporal bone, viewed from above and behind,

giving the direction of the sections pictured in Figs. 965—968.

The *vestibule, vestibulum* (continued) (see Figs. 958, 959, 961, 962 and 965—967). The crista vestibuli close behind and over the fenestra vestibuli presents a variably developed prong, *pyramis vestibuli.* Upon this and in its immediate neighborhood are the minute openings which correspond to the foramina of the area vestibularis superior (see p. 850) and serve for the passage of the upper branch of the n. vestibularis (see p. 727); together they are designated as the *macula cribrosa superior.* Under the forked posterior end of the crista vestibuli lies a small depressed area, *recessus cochlearis* (see Figs. 965—967); it is separated behind by a ridge from the opening of the crus ampullare canalis semicircularis posterioris, goes forward immediately upon the beginning of the lamina spiralis ossea and lamina spiralis secundaria and receives the caecum vestibulare of the ductus cochlearis (see p. 853). Close behind this area, in the anterior wall of the ampulla ossea posterior (see Fig. 967), a small, perforated area, *macula cribrosa inferior,* is visible, which contains the openings of small canals beginning in the foramen singulare (see p. 850) and through which the n. ampullaris posterior (see p. 728) arrives in the vestibulum. The recessus cochlearis leads medianward directly into the vestibular opening of the scala vestibuli cochleae (see p. 849) which occupies the lowermost portion of the medial wall of the vestibule.

The vestibule is connected in the macerated bone in front laterally with the tympanic cavity through the *fenestra vestibuli* (see p. 834), in which the foot-plate of the stirrup is fastened by the lig. annulare basis stapedis. Opening into the vestibule besides are the semicircular canals, the five mouths of which are so distributed over the lateral and inferior walls (see Fig. 966) that the crus ampullare of the lateral canal opens over the fenestra vestibuli and over it the crus ampullare of the superior semicircular canal; behind the former lies the opening of its crus simplex and over this that of the crus commune, and in the posterior part of the floor the opening of the crus ampullare of the posterior semicircular canal is to be found.

Bony semicircular canals, *canales semicirculares ossei* (see also Figs. 958—961 and 965—967), are three nearly semicircular curved bony tubes, each of which is connected at two places with the wall of the vestibule. They lie in three planes nearly perpendicular to one another and together form a right-angled corner (see Figs. 958—960). In detail, however, these angles as well as the form, length, width and curvature of the semicircular canals are subject to fairly great variations, but are alike on the right and the left side of the same individuals. The shortest of them, *canalis semicircularis lateralis,* is directed lateral and backward, adjoins lateralward and forward the recessus epitympanicus and there causes the prominentia canalis semicircularis lateralis; it does not lie exactly in a („horizontal") plane drawn through the lowest points of both infraorbital margins and the highest points of both ear-openings but forms with it an angle of about 24°, open lateralward, dorsalward and downward.

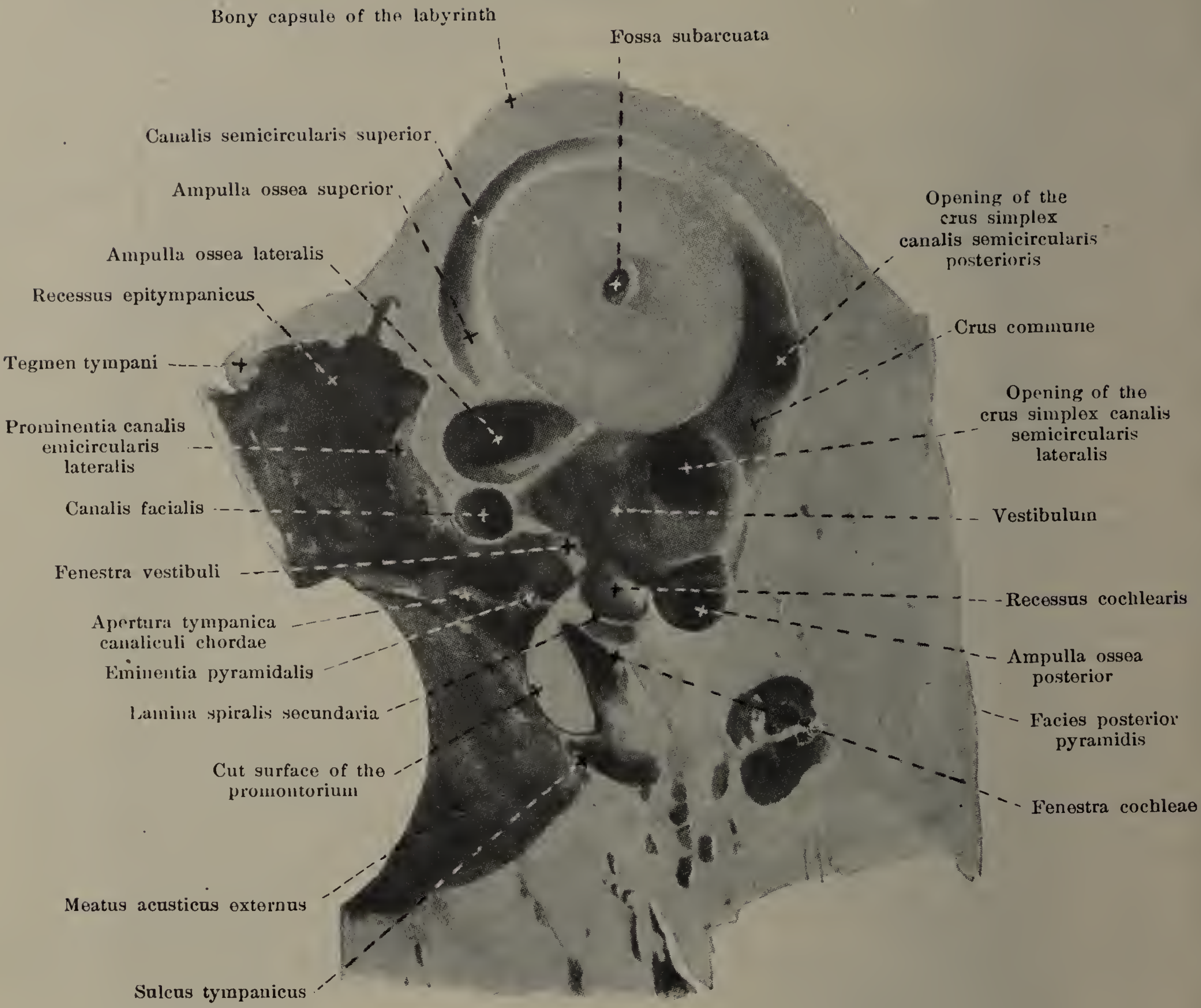

Beginning of the crus simplex canalis semicircularis posterioris
Crus commune
Compact bony substance of the capsule of the labyrinth
Opening of the crus simplex canalis semicircularis lateralis
Recessus ellipticus
Ampulla ossea lateralis
Canalis semicircularis lateralis
Crista vestibuli
Recessus cochlearis
Margin of the fenestra vestibuli
Canalis facialis
Lamina spiralis secundaria
Fossa incudis
Eminentia pyramidalis
Sinus posterior
Fossula fenestrae cochleae
Apertura tympanica canaliculi chordae
Prominentia styloidea
Meatus acusticus externus
Promontorium
Sulcus tympanicus
Beginning of the crus simplex canalis semicircularis superioris
Mouth of the crus ampullare canalis semicircularis posterioris
Area vestibularis superior
Crista transversa
Foramen singulare
Meatus acusticus internus
Recessus sphaericus
Lamina spiralis ossea
Area cochleae
Basis modioli
Canalis spiralis modioli
Lamina spiralis ossea
Basal turn
Modiolus
Compact bony substance of the capsule of the labyrinth
Middle turn
Apical turn
Lamina modioli
Semicanalis m. tensoris tympani
Semicanalis tubae auditivae with cellulae pneumaticae tubariae
Paries jugularis cavi tympani
Cut surface of the pars tympanica oss. temporalis

965. Transversal section through the right temporal bone, lower half, viewed from above. Magnification: 5:1.

Concerning the direction of the section see Figs. 963 and 964.

(The crus commune, which was not struck by the section, has been subsequently opened.)

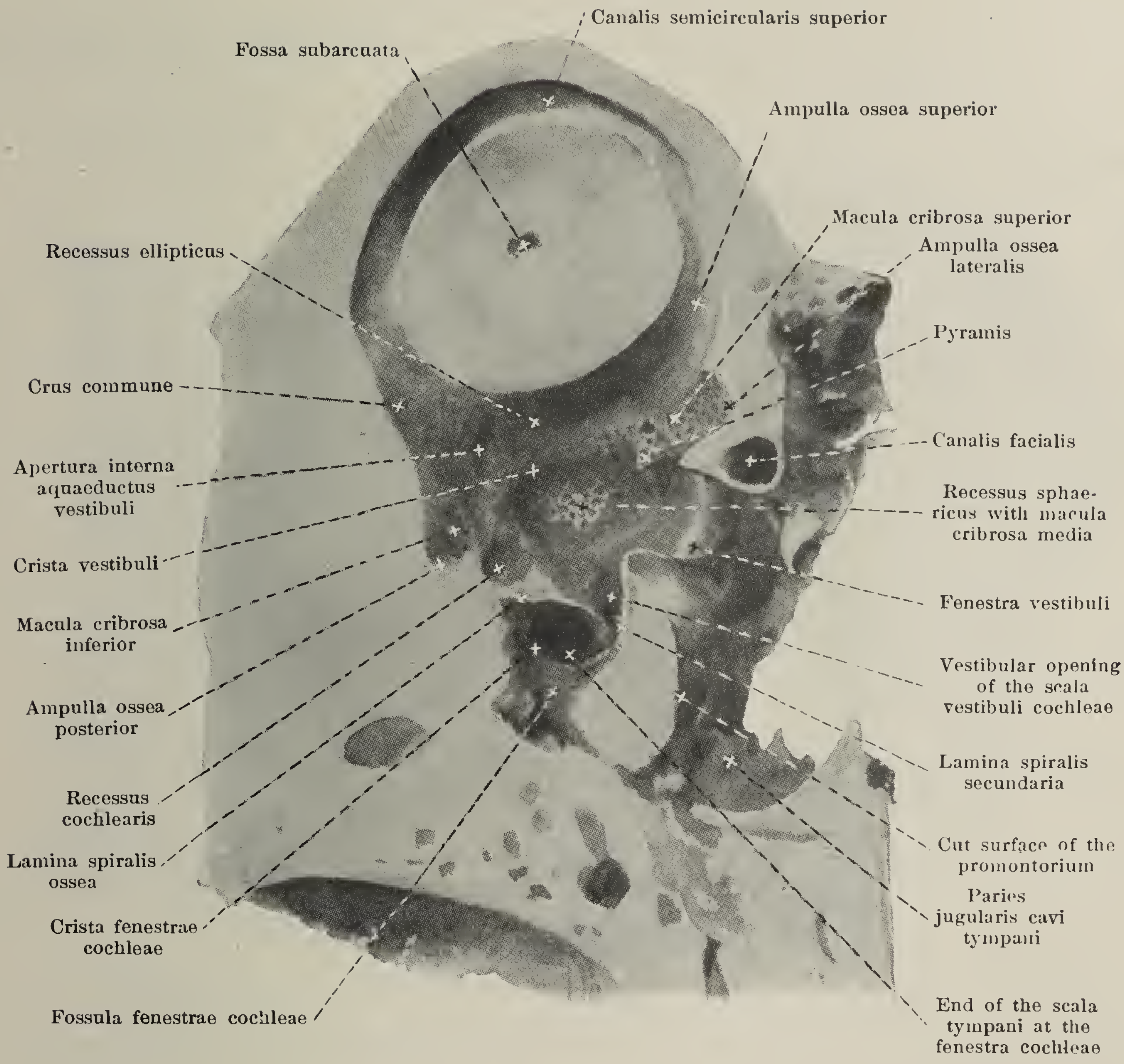
Bony semicircular canals (continued) (see Figs. 958—961, 966 and 967). The two other semicircular canals run in approximately vertical planes (see p. 842); one of them, *canalis semicircularis superior*, stands at right angles to the axis of the pyramid of the temporal bone, and usually gives rise on its facies anterior to the projecting eminentia arcuata, the other, the longest of all, *canalis semicircularis posterior*, lies nearly parallel to the facies posterior pyramidis and goes above and below considerably beyond the plane of the lateral semicircular canal. Each of them deviates in part somewhat from its plane and so presents a slight "surface curvature"; the posterior and superior, viewed from the side, appear slightly S-shaped, the horizontal curved so as to be slightly C-shaped. The lumen of each semicircular canal has the form of an ellipse the largest diameter of which falls in the plane of the canal; it is largest (measured at the vertex of the semicircular canal) in the posterior canal, smallest in the superior.


Bony capsule of the labyrinth
Fossa subarcuata
Canalis semicircularis superior
Ampulla ossea superior
Ampulla ossea lateralis
Recessus epitympanicus
Tegmen tympani
Prominentia canalis semicircularis lateralis
Canalis facialis
Fenestra vestibuli
Apertura tympanica canaliculi chordae
Eminentia pyramidalis
Lamina spiralis secundaria
Cut surface of the promontorium
Meatus acusticus externus
Sulcus tympanicus
Opening of the crus simplex canalis semicircularis posterioris
Crus commune
Opening of the crus simplex canalis semicircularis lateralis
Vestibulum
Recessus cochlearis
Ampulla ossea posterior
Facies posterior pyramidis
Fenestra cochleae

966. Vertical section through the right temporal bone, lateral portion viewed from the medial side.
Magnification: 5 : 1.

(For the corresponding medial portion see Fig. 967.) Concerning the direction of the section see Figs. 963 and 964.

Bony semicircular canals (continued) (see also Figs. 958—961, 965 and 967). One of the two ends of each semicircular canal presents a flask-like dilatation, *ampulla ossea;* the corresponding limb of the semicircular canal is called the *crus ampullare,* the other non-dilated one, the *crus simplex.* The ampullae osseae vary somewhat in length and width, that of the lateral semicircular canal, *ampulla ossea lateralis,* and that of the superior semicircular canal, *ampulla ossea superior,* lie at their lateral ends, that of the posterior semicircular canal, *ampulla ossea posterior,* at its inferior end. The two ends of the lateral semicircular canal open separately into the vestibule: the same is also true of the crura ampullaria of the posterior and of the superior semicircular canal, the former on the lower wall, the latter close to the upper wall of the vestibulum. The simple limbs of the superior and posterior semicircular canals unite on the contrary to form a common round limb, *crus commune,* $3^1/_2$—4 mm long, which forms an angle of 40—50° with the horizontal plane (see p. 844) and opens directly behind and over the crus simplex of the lateral semicircular canal into the vestibule.

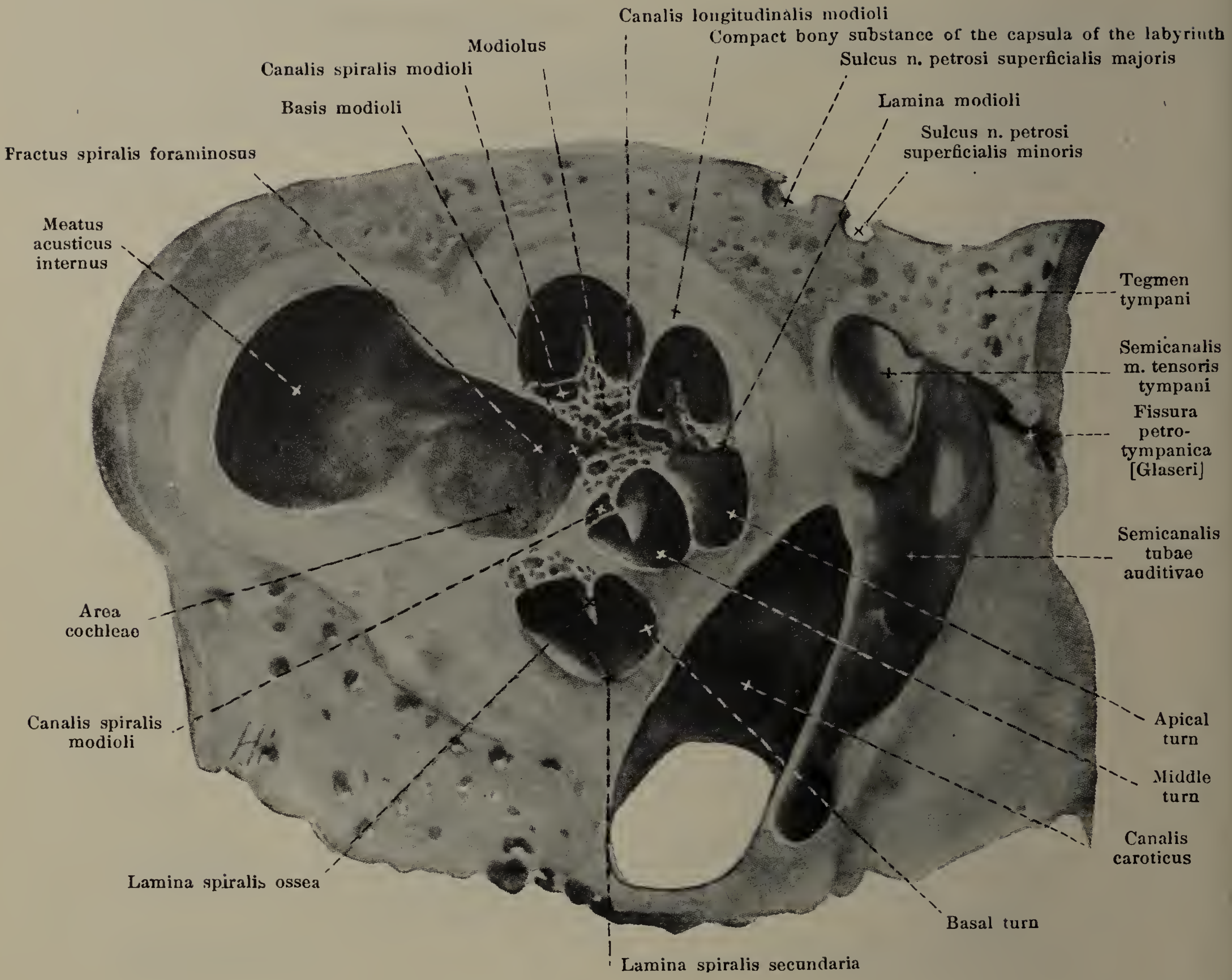

Canalis semicircularis superior
Fossa subarcuata
Ampulla ossea superior
Macula cribrosa superior
Ampulla ossea lateralis
Recessus ellipticus
Pyramis
Crus commune
Canalis facialis
Apertura interna aquaeductus vestibuli
Recessus sphaericus with macula cribrosa media
Crista vestibuli
Fenestra vestibuli
Macula cribrosa inferior
Vestibular opening of the scala vestibuli cochleae
Ampulla ossea posterior
Lamina spiralis secundaria
Recessus cochlearis
Cut surface of the promontorium
Lamina spiralis ossea
Paries jugularis cavi tympani
Crista fenestrae cochleae
Fossula fenestrae cochleae
End of the scala tympani at the fenestra cochleae

967. Vertical section through the right temporal bone, medial portion, viewed from the lateral side. Magnification: 5:1.

(The corresponding lateral portion is shown in Fig. 966.)

Concerning the direction of the section see Figs. 963 and 964.

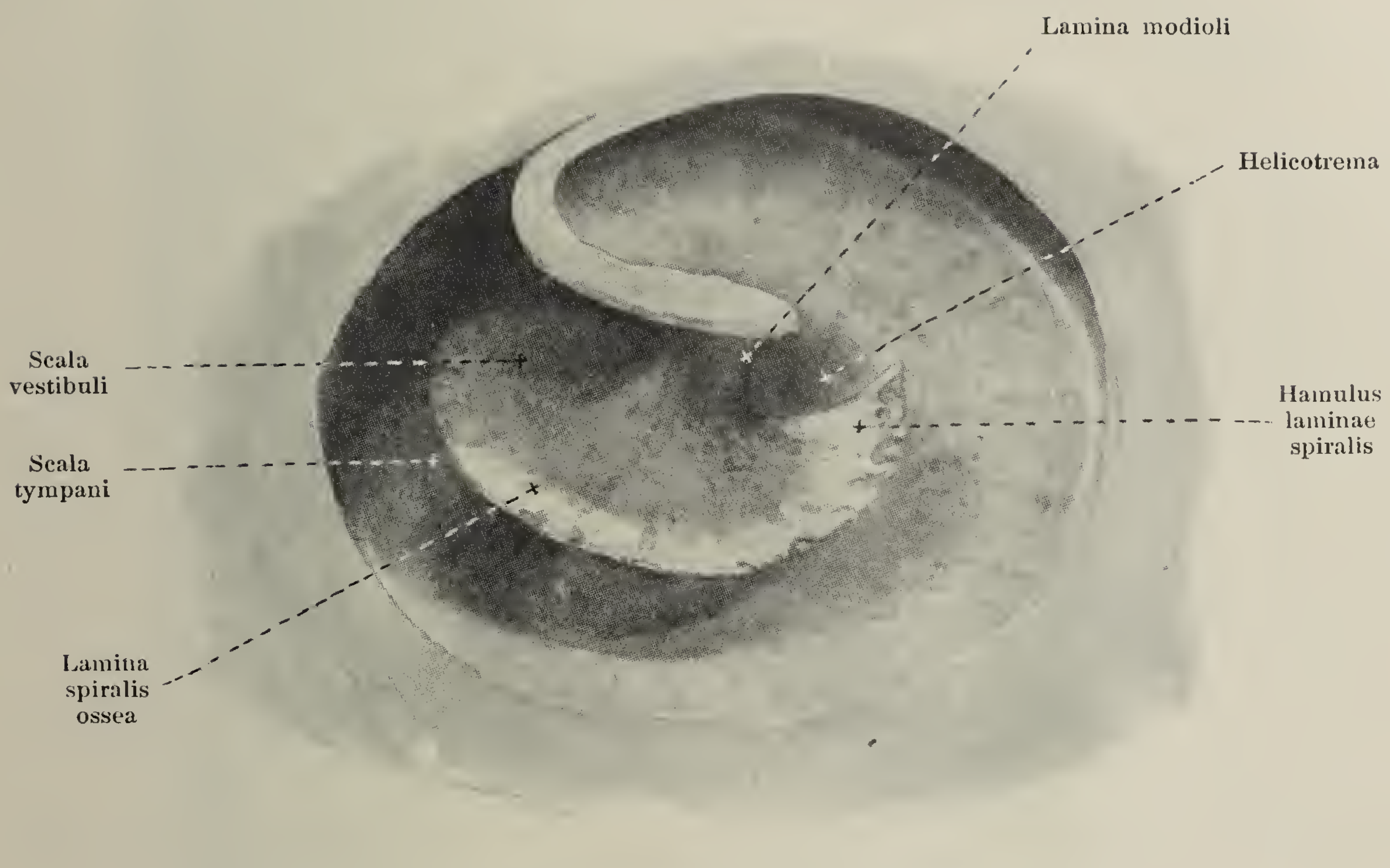
The *snail, cochlea* (see also Figs. 958—962, 965, 968 and 969), is a low cone formed of hard bony substance, its axis being placed horizontally; its base, *basis cochleae* (see also p. 842), is directed toward the anterior part of the fundus meatus acustici interni, its blunt *apex, cupula,* toward the semicanalis m. tensoris tympani; its inferior, anterior wall directly adjoins the rectangular curvature of the canalis caroticus in the temporal bone. In its interior it contains a spirally wound canal, *canalis spiralis cochleae,* which begins in the anterior and lowest portion of the vestibule (see p. 844) and at the fenestra cochleae, and ends blind at the apex. The canalis spiralis cochleae is on the average 37.5 mm long, runs from its beginning in the vestibule at first curved somewhat downward, medial from the promontorium, forward and medianward as far as the canalis caroticus (see Fig. 962), there bends around upward and curls up on itself first loosely, then more closely, in the form of a spiral, so that usually 2¾ turns arise, called the *basal turn,* the *middle turn* and the *apical turn;* these turns do not lie in one plane, but each subsequent one becomes elevated laterally over the preceding and is at the same time more markedly curved than it (see Figs. 958 and 962); the *cupula* is formed by the blind end and the last portion of the third turn.


Canalis longitudinalis modioli
Compact bony substance of the capsula of the labyrinth
Sulcus n. petrosi superficialis majoris
Modiolus
Canalis spiralis modioli
Lamina modioli
Basis modioli
Sulcus n. petrosi superficialis minoris
Fractus spiralis foraminosus
Meatus acusticus internus
Tegmen tympani
Semicanalis m. tensoris tympani
Fissura petro-tympanica [Glaseri]
Semicanalis tubae auditivae
Area cochleae
Apical turn
Canalis spiralis modioli
Middle turn
Canalis caroticus
Lamina spiralis ossea
Basal turn
Lamina spiralis secundaria

968. Vertical section through the right cochlea,
medial portion viewed from the lateral side. Magnification: 6 : 1.

Concerning the direction of the section see Figs. 963 and 964.

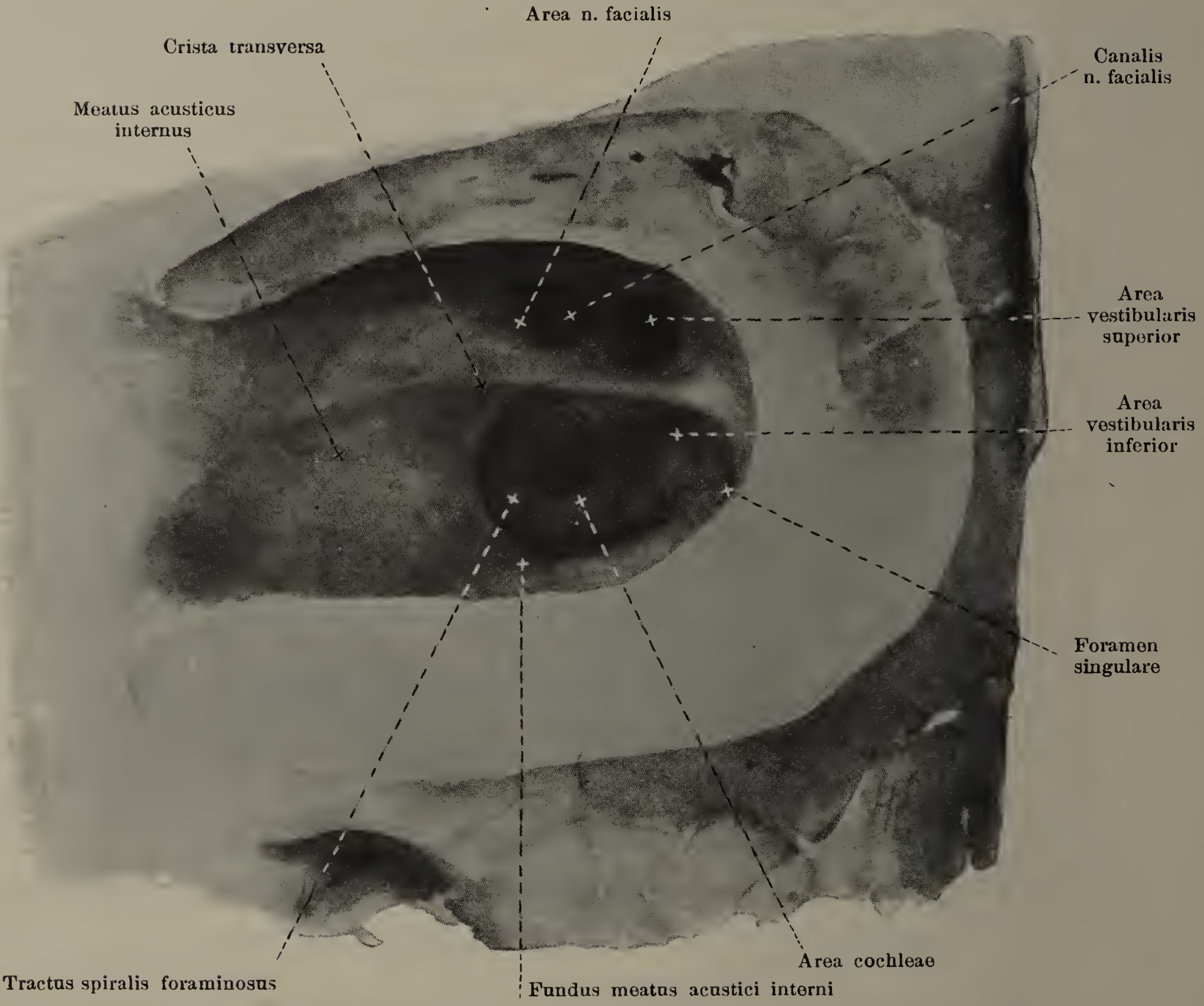
Cochlea (continued) (see also Figs. 958—962, 965—967 and 969). The axial space of the cochlea around which the canalis spiralis is coiled consists of spongy bone-substance and is called the *modiolus (spindle);* this represents at the same time the inner wall of the canal; the outer wall of the canal is formed by the compact bony capsule of the labyrinth (see p. 842) and is connected with the spindle by thin lamellae of bone, which at the same time form the septa between the neighboring turns. The modiolus is hollowed out on that surface which is turned toward the fundus meatus acustici interni, *basis modioli,* almost as far as half the height of the first turn and there forms the floor of the area cochleae (see p. 850). The spindle is perforated by one larger or several smaller canals, *canales longitudinales modioli,* running parallel to the axis. At the apex the spindle goes over into a thin, compact bony layer, *lamina modioli* (see also Figs. 962, 965 and 969), around which the end of the apical turn curves; the lamina modioli ends by a concave margin, is attached to the cupula and goes over directly into the septum between the second and the third turn. The diameters of the lumen of the canalis spiralis cochleae parallel and perpendicular to the axis of the modiolus are almost equal (about 2 mm) in the first half of the basal turn; in the second half of the basal turn and in the middle turn, the height (parallel to the axis) is 2 mm, the breadth (perpendicular to the axis) 1.5 mm; in the third turn the height quickly diminishes and the breadth exceeds it.



969. Cupula of the right bony chochlea, opened,

viewed from the outside. Magnification: 15:1.

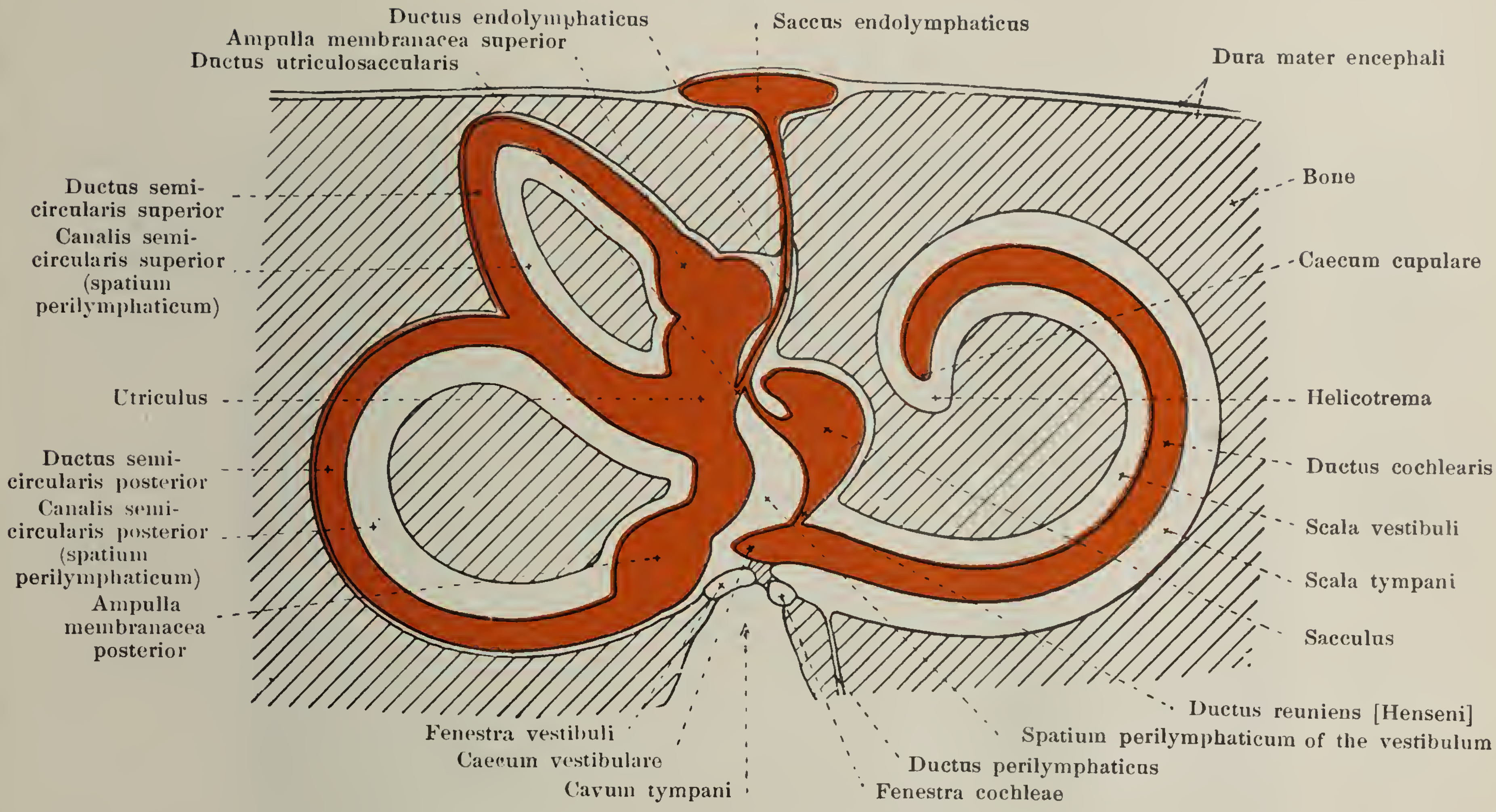
Cochlea (continued) (see also Figs. 958—962 and 965—968). Springing out from the spindle is a delicate bony plate, *lamina spiralis ossea, bony spiral layer,* midway between two septa, for some distance into the lumen of the canalis spiralis; it divides this incompletely into the ***scala vestibuli, vestibular staircase,*** turned toward the cupula, and the ***scala tympani, tympanic staircase,*** nearer the base of the cochlea, the two becoming completely separated by the interposition of the membranous cochlear canal. The spiral layer as well as the vestibular and tympanic staircases run along the whole canalis spiralis and are therefore also turned in a spiral. In the region of the basal turn the scala tympani is wider than the scala vestibuli; in the middle and apical turn the reverse is true. The breadth of the spiral layer corresponds approximately to half the breadth of the canalis spiralis cochleae (see p. 848) and accordingly diminishes somewhat from the base toward the apex; at the beginning of the third turn, the spiral layer becomes separated from the modiolus and ends in a free projecting process, *hamulus laminae spiralis*, ending tapered off; between the concave margin of the latter, the lamina modioli and the terminal portion of the ductus cochlearis (see p. 853), a round opening, *helicotrema* (see also Figs. 972 and 974), forms the sole connection between the scala vestibuli and scala tympani which are otherwise separated from one another by the ductus cochlearis. Along the attachment of the lamina spiralis ossea in the modiolus runs a triangular canal, *canalis spiralis modioli,* for the ganglion spirale n. cochlearis. The lamina spiralis ossea begins directly lateral from and in front of the recessus cochlearis of the vestibule (see Figs. 962, 965 and 967) as a broad plate and goes over there behind into a smaller, similarly formed bony platelet, *lamina spiralis secundaria,* which runs at first separated from it by a narrow, then by a broader slit, on the inferior surface of the first half of the basal turn (see also Figs. 959, 962, 965, 967 and 968), becoming gradually lower as it goes and finally vanishing. Only the space situated lateral (toward the apex) from the two laminae spirales, the scala vestibuli, opens at its beginning in the vestibule; the medial (toward the base) of them, the scala tympani, ends there blind and in the macerated bone communicates with the tympanic cavity through the fenestra cochleae (see p. 834), but is otherwise separated from it by the membrana tympani secundaria; in this latter blind-sack-like portion lies the internal opening of the *canaliculus cochleae* (see p. 11).


Area n. facialis
Crista transversa
Meatus acusticus internus
Canalis n. facialis
Area vestibularis superior
Area vestibularis inferior
Foramen singulare
Area cochleae
Tractus spiralis foraminosus
Fundus meatus acustici interni

970. Right internal acoustic canal, viewed from the medial side. Magnification: 6:1.

(The upper, posterior and inferior walls have been in large part removed.)

Meatus acusticus internus, internal acoustic canal (see also p. 11 and Figs. 960, 965 and 968), is a short canal running nearly transversely and frontally, the lumen of which varies individually and which begins medial in a transversely oval opening, *porus acusticus internus*, bounded by a sharp lateral and blunt medial margin; the lateral end, *fundus meatus acustici interni, floor of the internal acoustic canal,* is closed by a bony plate, which is in large part also the medial wall of the vestibule and cochlea. It is divided into an upper and a lower area by a horizontal sharp ridge, *crista transversa.* The upper, smaller area, in an anterior depression, *area n. facialis,* contains the internal opening of the canalis facialis [Falloppii] (see p. 14) and in a posterior funnel-shaped depression, *area vestibularis superior,* contains several delicate openings of small canals which conduct the branches of the upper terminal ramus of the n. vestibularis (see p. 727) to the macula cribrosa superior of the vestibule (see p. 844). The lower, larger area presents in front a rounded depression, *area cochleae,* in which begins a broad, spiral band, curved like the cochlea, of variably-sized openings, *tractus spiralis foraminosus,* which ends in the lateral part; these foramina carry the bundles of the n. cochlearis directly to the basal turn or through the canales longitudinales modioli to the middle and apical turns. In the posterior part of the inferior area, close below the crista transversa, lies an area with small openings, *area vestibularis inferior,* which conducts the bundles of the n. saccularis (see p. 728) through small canaliculi to the macula cribrosa media of the vestibule (see p. 843), and somewhat medianward and behind it is to be found a single, larger opening, *foramen singulare,* whence the n. ampullaris posterior (see p. 728) passes through a longer, delicate canaliculus to the macula cribrosa inferior (see p. 844).


Ductus endolymphaticus
Ampulla membranacea superior
Ductus utriculosaccularis
Saccus endolymphaticus
Dura mater encephali
Ductus semicircularis superior
Canalis semicircularis superior (spatium perilymphaticum)
Bone
Caecum cupulare
Utriculus
Helicotrema
Ductus semicircularis posterior
Ductus cochlearis
Canalis semicircularis posterior (spatium perilymphaticum)
Scala vestibuli
Scala tympani
Ampulla membranacea posterior
Sacculus
Ductus reuniens [Henseni]
Spatium perilymphaticum of the vestibulum
Fenestra vestibuli
Caecum vestibulare
Ductus perilymphaticus
Cavum tympani
Fenestra cochleae

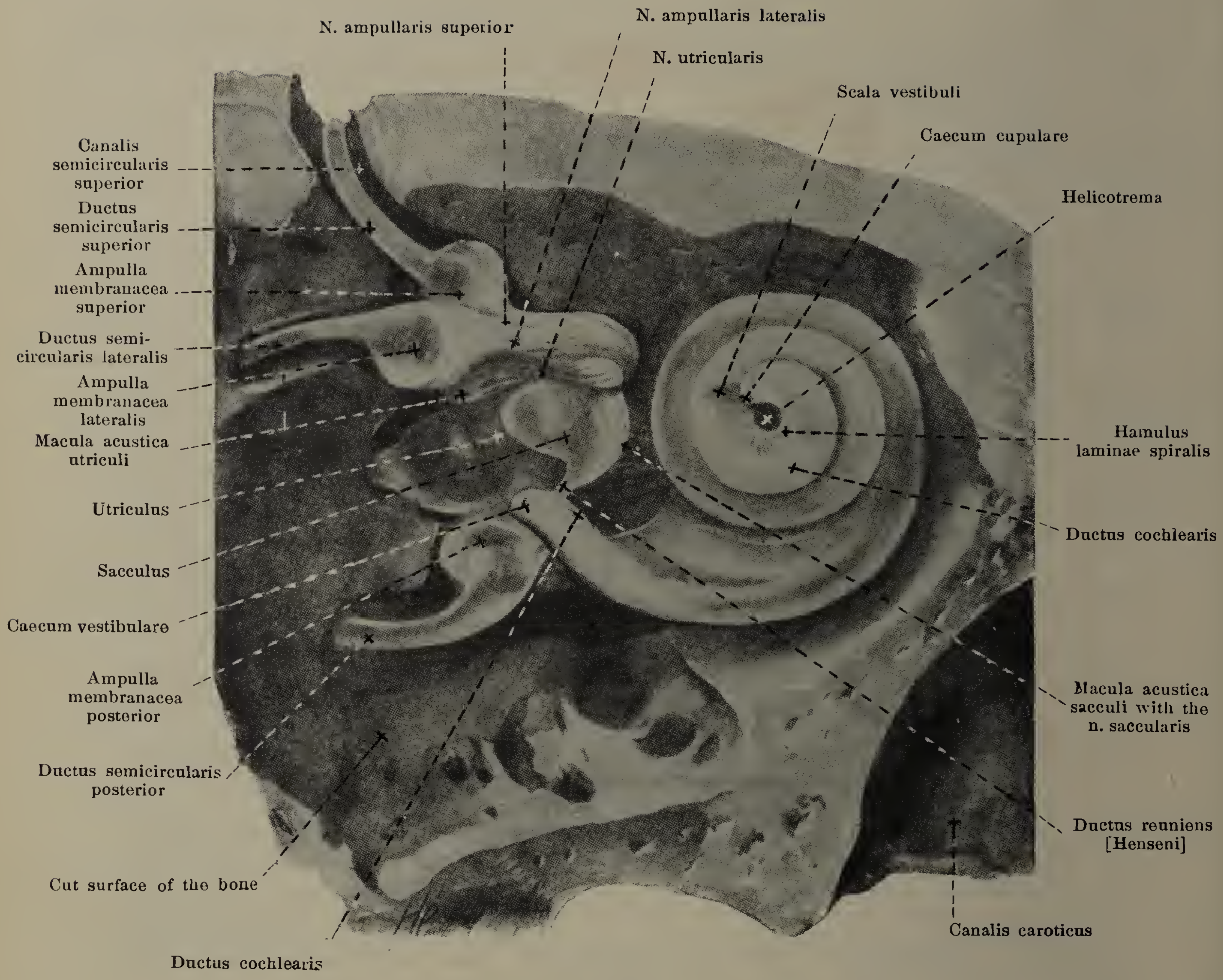
971. Scheme of the right bony and membranous labyrinth. Magnification: 5 : 1.

(The perilymphatic space is shown in white, the endolymphatic in red. The lateral semicircular canal it not shown.)

Labyrinthus membranaceus, membranous labyrinth (see also Figs. 972—977), is a system of connective tissue tubes which contain the terminations of the n. acusticus, lined by epithelium and filled by a clear fluid, *endolympha*, poor in albumen. These tubes or canals all communicate with one another but are completely shut off from the outside and lie in the spaces of the bony labyrinth, the forms of which they approximately repeat. Their transverse diameter is everywhere smaller than that of the bony canals concerned, and there remains between their delicate wall and the bone a system of communicating spaces which are lined with endothelium, containing a clear, somewhat thinner fluid, *perilympha*, poor in albumen, and together are known as the *spatium perilymphaticum.*

In the vestibulum the membranous labyrinth is formed by the two *vestibular saccules*, the *utriculus* and the *sacculus.* The *utriculus* (see also Figs. 972, 973 and 976) is an approximately tube-shaped vesicle directed from above and in front downward and backward; it lies in the recessus ellipticus of the vestibule (see p. 843), is there in large part fairly firmly attached to the bone by connective tissue, and by the bundles of the n. utricularis emerging from the macula cribrosa superior, but otherwise separated by perilymphatic spaces from the wall of the vestibule. The upper slightly constricted part presents on its anterior, lateral surface an oval thickened place of a whitish color, *macula acustica utriculi*, in which the fibres of the n. utricularis (see p. 727) terminate.

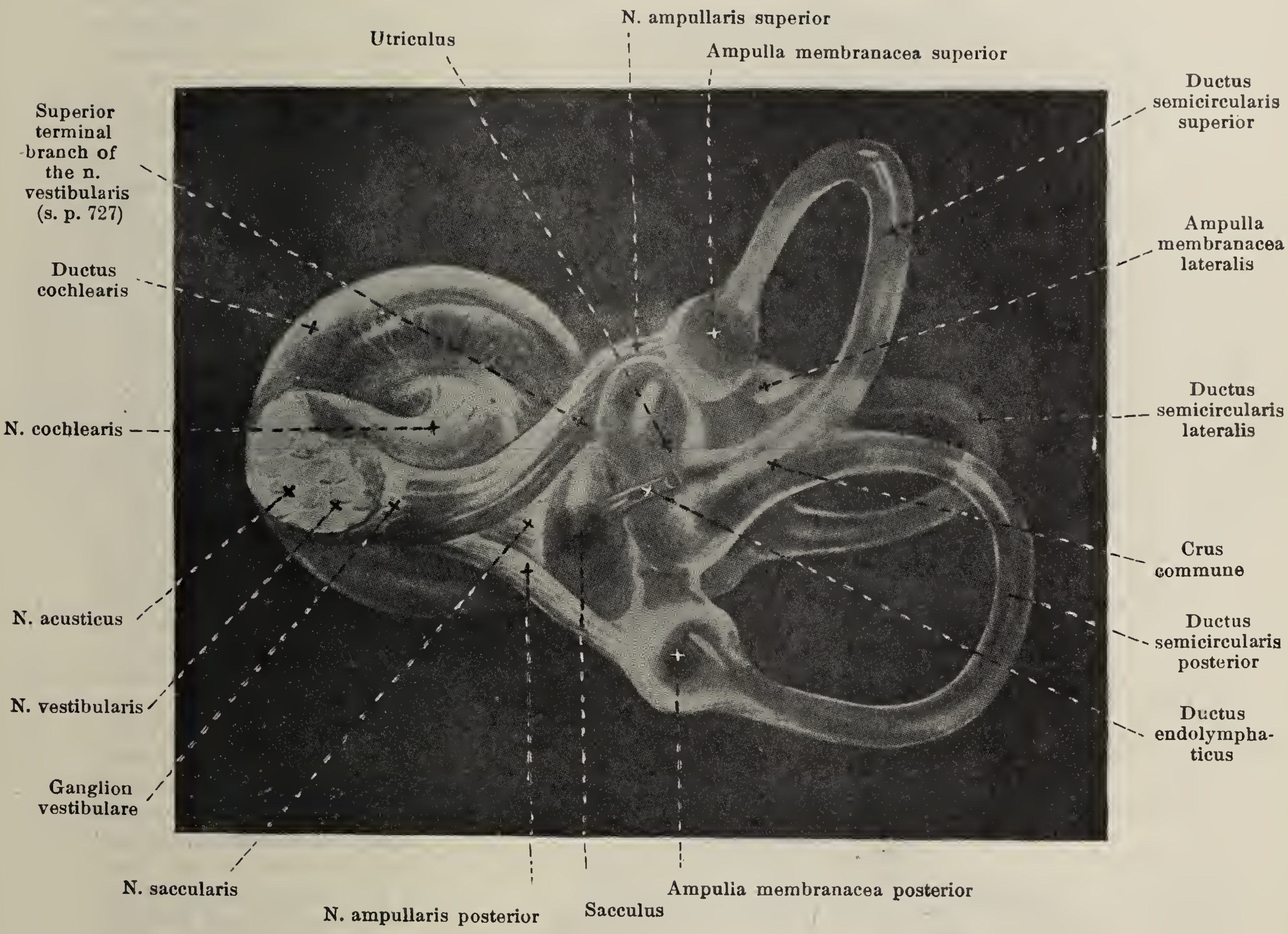
In the utriculus open the three *membranous semicircular canals, ductus semicirculares*, which lie in the three bony semicircular canals, correspond to them exactly in arrangement and course, and are distinguished accordingly as *ductus semicircularis lateralis, superior, posterior;* they empty by five openings into the utriculus. Each membranous semicircular duct lies eccentrically on the convex side of the bony canal, and its diameter is only one-third of that of the bony canal; the perilymphatic space is also very large here and is crossed by single strands of connective tissue. Corresponding to the three ampullae osseae there are also three *ampullae membranaceae* in the membranous ducts, which analogous to the bony ones are designated *ampulla membranacea lateralis, superior, posterior;* they represent very marked dilatations of the membranous ducts, appear sharp and large on the concave side of the ducts and much more completely fill up their bony space; each of them presents on its surface corresponding to the convex side of the semicircular canal a transverse groove, *sulcus ampullaris*, in which the n. ampullaris (see pp. 727 and 728) enters, and a sickle-shaped ridge, *crista ampullaris*, projecting thence into the lumen.


N. ampullaris superior
N. ampullaris lateralis
N. utricularis
Scala vestibuli
Caecum cupulare
Helicotrema
Canalis semicircularis superior
Ductus semicircularis superior
Ampulla membranacea superior
Ductus semicircularis lateralis
Ampulla membranacea lateralis
Macula acustica utriculi
Utriculus
Sacculus
Caecum vestibulare
Ampulla membranacea posterior
Ductus semicircularis posterior
Cut surface of the bone
Ductus cochlearis
Hamulus laminae spiralis
Ductus cochlearis
Macula acustica sacculi with the n. saccularis
Ductus reuniens [Henseni]
Canalis caroticus

972. Right membranous labyrinth of an adult, partially exposed, lateral and front view. Magnification: 5:1.

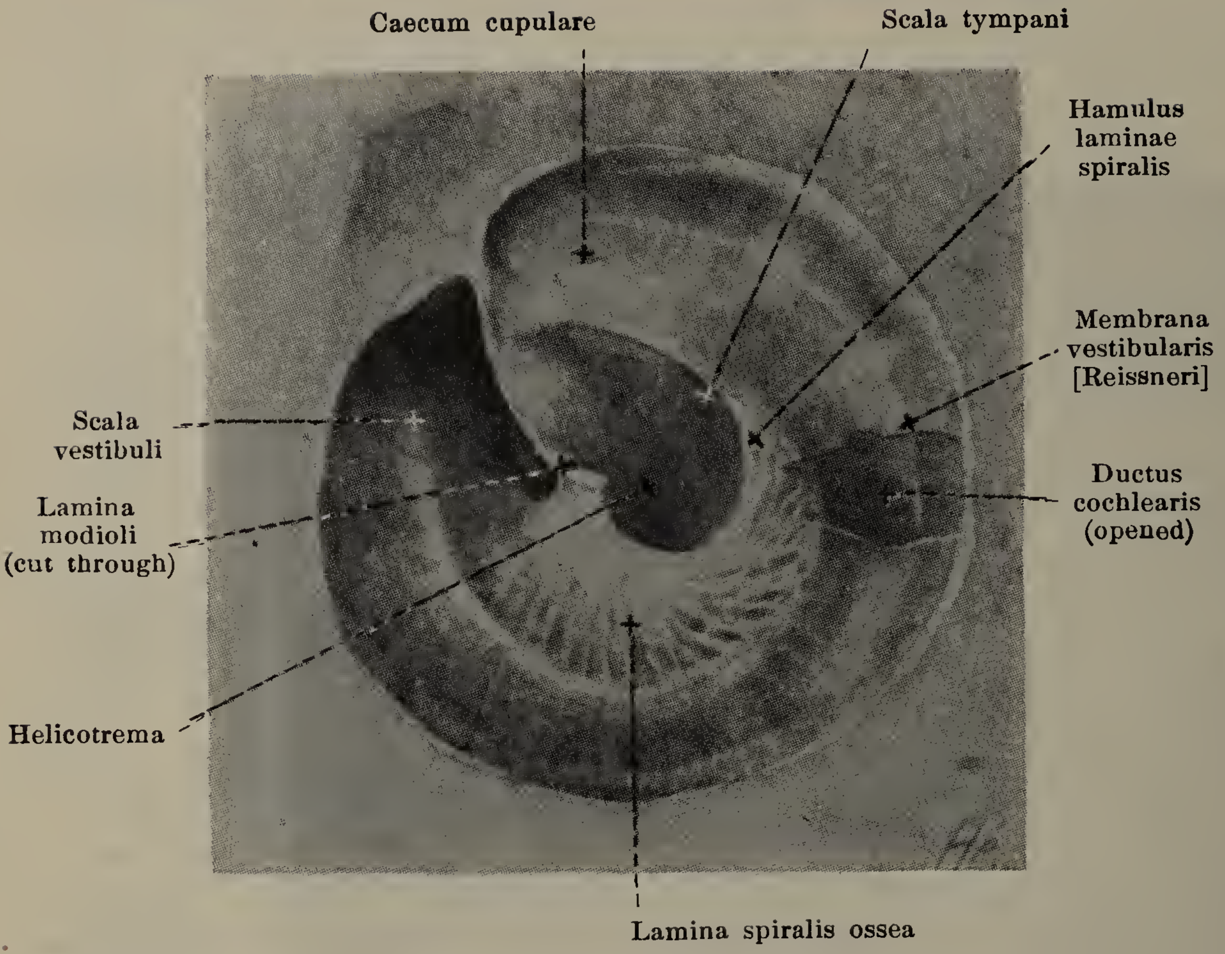
(The lateral and upper portions of the bony capsule of the labyrinth have been removed in a decalcified temporal bone. The scala vestibuli has been opened only at its beginning and at its end.)

Labyrinthus membranaceus (continued) (see also Figs. 971 and 973—977). The *sacculus* is a flattened oval vesicle with its long diameter vertically placed; it lies in the recessus sphaericus of the vestibule (see p. 843), is fairly firmly attached to the bone there by connective tissue and the bundles of the n. saccularis emerging from the macula cribrosa media, but otherwise is separated from the walls of the vestibule by a large, perilymphatic space. Its lower end narrows gradually to become the *ductus reuniens [Henseni]*, a delicate duct, 0.5 mm wide, 1 mm long, connecting the sacculus with the ductus cochlearis (see p. 853). On the medial, anterior surface of the sacculus a thickened area, *macula acustica sacculi*, can be made out in which the fibres of the n. saccularis (see p. 728) terminate. The sacculus is not directly connected with the utriculus, but only indirectly through the *ductus endolymphaticus;* this arises as a very fine canal from the posterior wall of the sacculus, receives the short and very fine *ductus utriculosaccularis* which goes off from the anterior, medial wall of the utriculus, and then passes through the aquaeductus vestibuli to the posterior surface of the pyramid of the temporal bone; it ends there in a flattened caecal dilatation, *saccus endolymphaticus*, which is situated just below the apertura externa aquaeductus vestibuli in a duplicature of the dura mater encephali and is not connected with the surrounding lymph spaces.

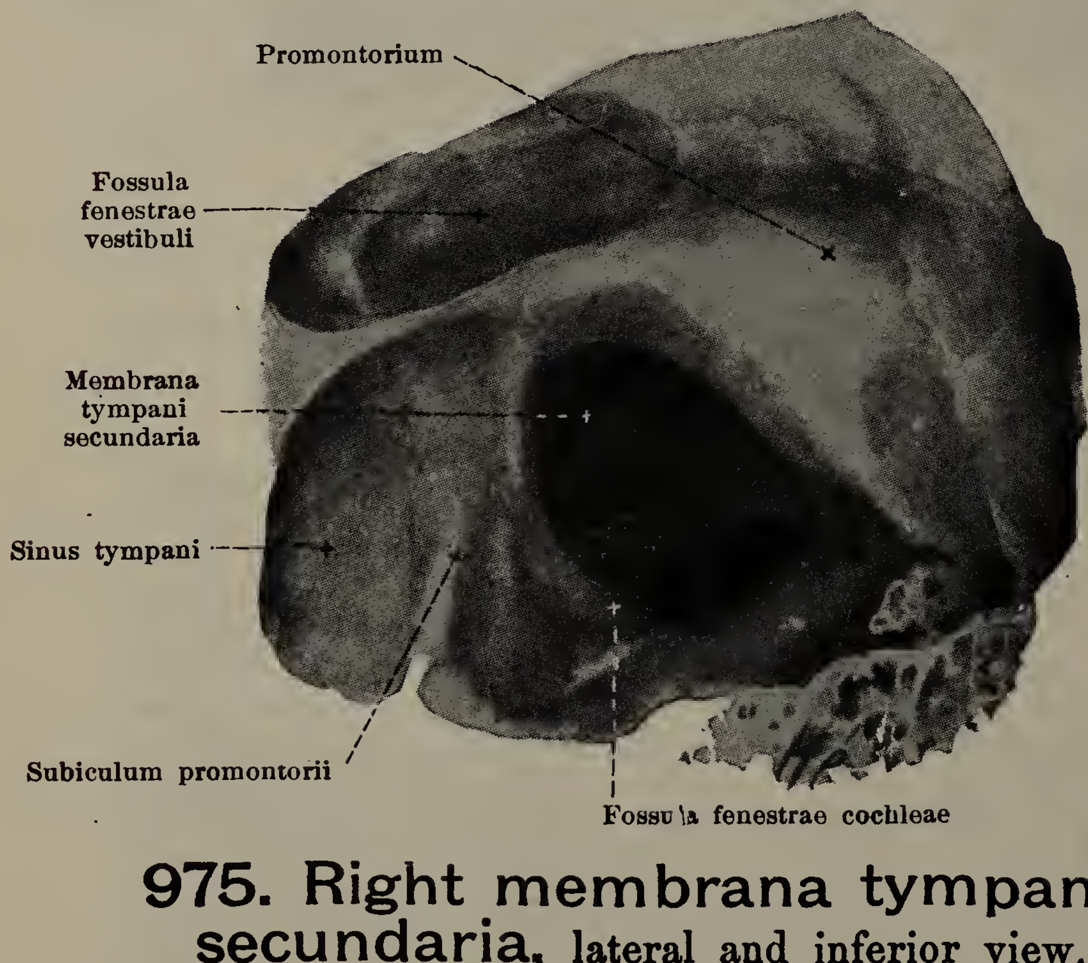

N. ampullaris superior
Utriculus
Ampulla membranacea superior
Superior terminal branch of the n. vestibularis (s. p. 727)
Ductus semicircularis superior
Ductus cochlearis
Ampulla membranacea lateralis
N. cochlearis
Ductus semicircularis lateralis
Crus commune
N. acusticus
Ductus semicircularis posterior
N. vestibularis
Ductus endolymphaticus
Ganglion vestibulare
N. saccularis
N. ampullaris posterior
Sacculus
Ampulla membranacea posterior

973. Right membranous labyrinth of an adult,
isolated, medial and posterior view. Magnification: 5:1.

Labyrinthus membranaceus (continued) (see also Figs. 971, 972 and 974—977). The cochlear part of the membranous labyrinth is formed by the *ductus cochlearis.* This begins in the recessus cochlearis of the vestibule, extends within the canalis spiralis cochleae as a narrow spirally turned duct as far as the end of the apical turn where it ends blind; near its beginning it is united with the sacculus by the ductus reuniens [Henseni] It is in large part triangular in cross-section (see Fig. 977). Its outer wall unites with the thickened periosteum of the inner surface of the cochlear canal. Its wall parallel to the base of the cochlea runs in the direction of the lamina spiralis ossea from its free margin to the *ligamentum spirale cochleae,* a ridge-like projection of the periosteum of the outer wall; it consists of a fibrous plate of connective tissue, *lamina basilaris,* and supports the *organon spirale [Cortii],* an epithelial structure which contains the termination of the fibres of the n. cochlearis (see p. 728). The third wall, *membrana vestibularis [Reissneri],* is remarkably thin, arises from the lamina spiralis ossea near its free margin and passes at an angle of approximately 45° to the outer wall. The ductus cochlearis thus separates two perilymphatic spaces from one another, of which that near the membrana vestibularis is called the *scala vestibuli,* that near the lamina basilaris, the *scala tympani.* In the apical turn (see Fig. 974) the somewhat flattened ductus cochlearis projects beyond the hamulus laminae spiralis, its blind end, *caecum cupulare,* being deposited in the cupular cavity of the apical turn and so helping to form the *helicotrema* (see p. 849). The beginning of the ductus cochlearis is also in the form of a blind-sack, and projects a little beyond the opening of the ductus reuniens [Henseni]; this portion is called the *caecum vestibulare* and rests in the recessus cochlearis of the vestibule (see p. 844). The perilymphatic space communicates with the cavum subarachnoideale by a fine canal, *ductus perilymphaticus,* situated in the canaliculus cochleae, near the v. canaliculi cochleae.



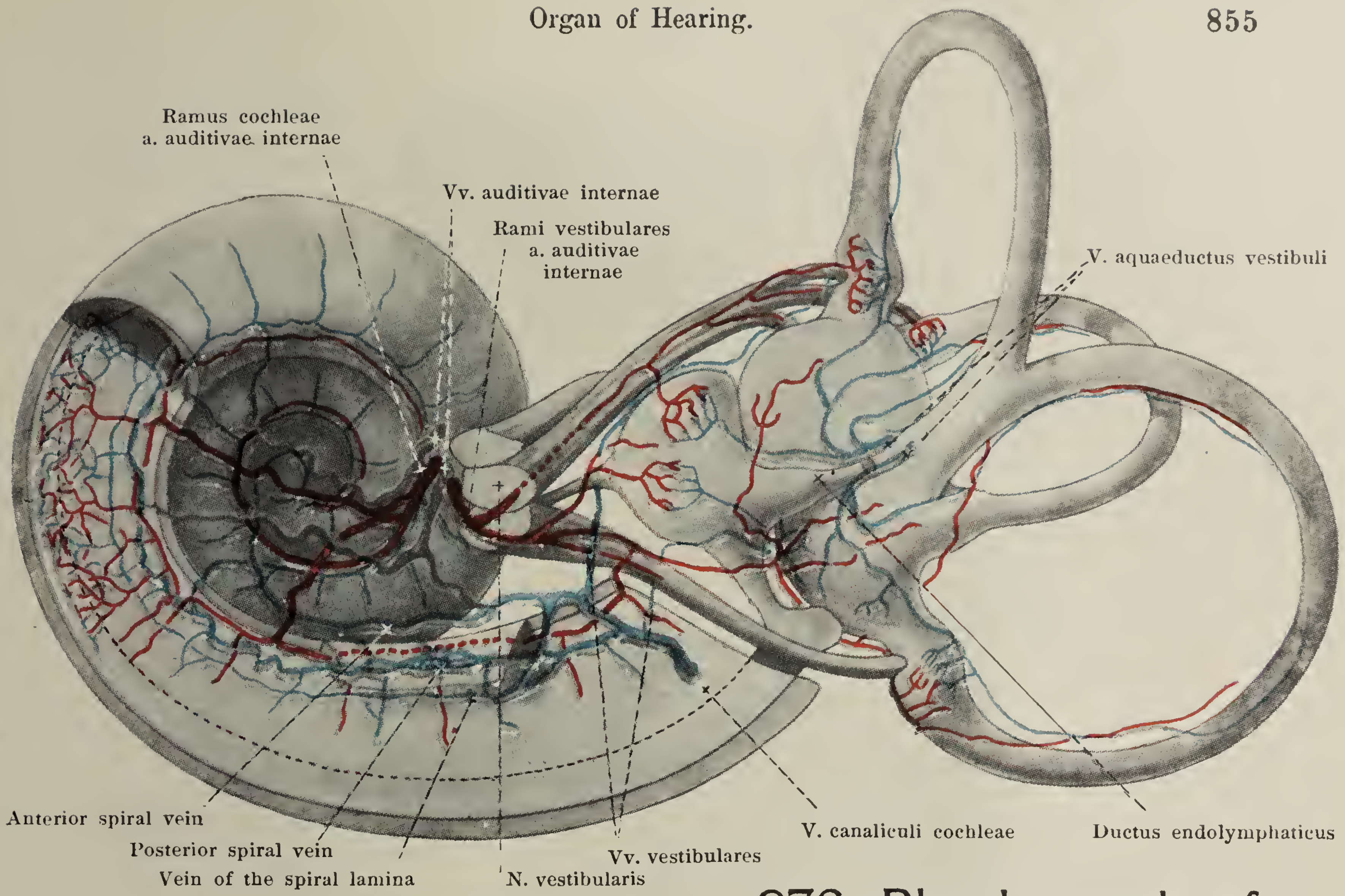
974. Cupula of the right cochlea, opened, viewed from the outside. Magnification: 15:1.


Promontorium
Fossula fenestrae vestibuli
Membrana tympani secundaria
Sinus tympani
Subiculum promontorii
Fossula fenestrae cochleae

975. Right membrana tympani secundaria, lateral and inferior view. Magnification: 12:1.

The fenestra cochleae is closed by a thin connective tissue membrane, ***membrana tympani secundaria (accessory ear-drum membrane)*** (see Fig. 975), which arises on the crista fenestrae cochleae (see p. 835) and is usually bulged somewhat into the scala tympani; its lateral surface is covered by the mucous membrane of the tympanic cavity which is continued upon it with one or several folds.

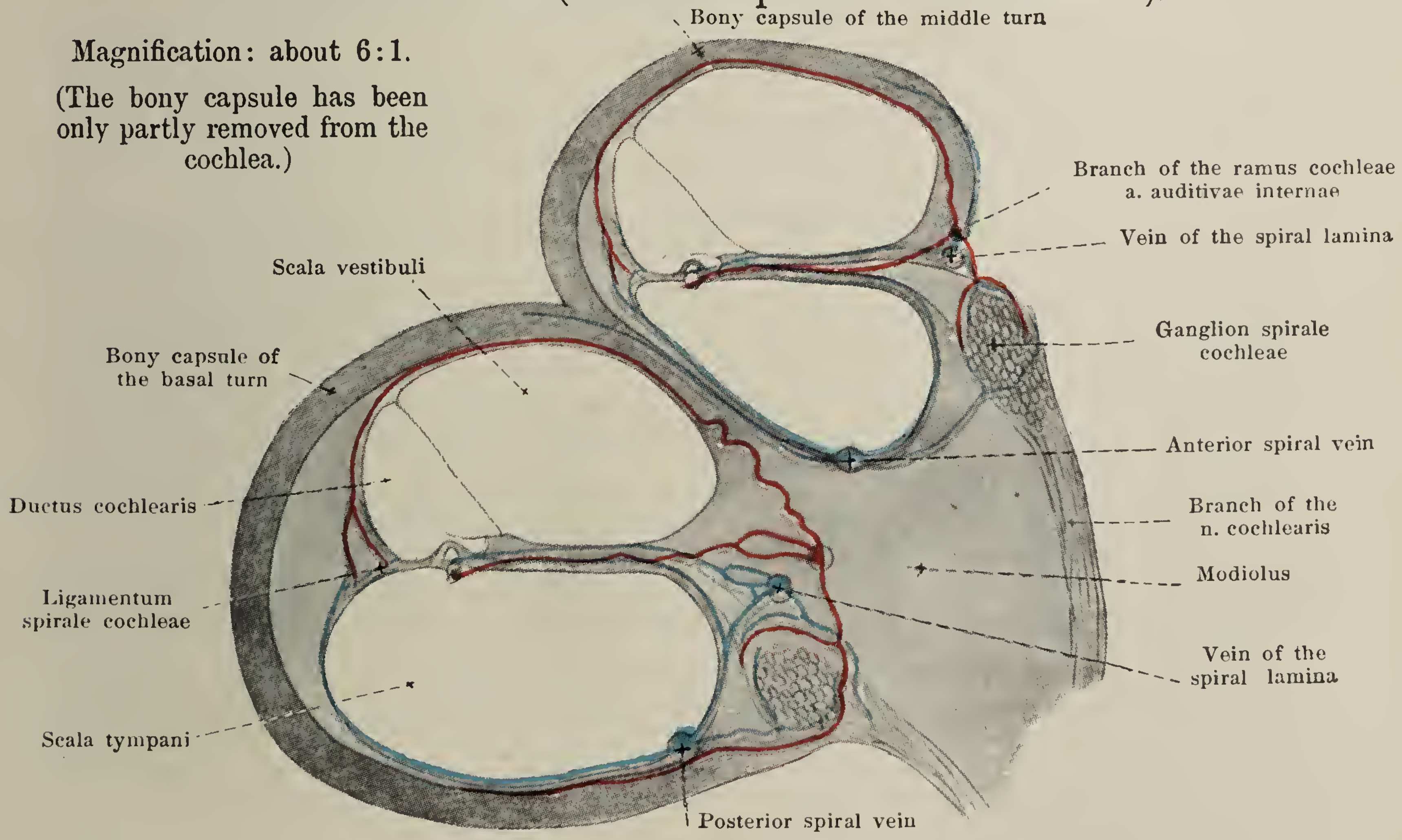
Blood vessels of the internal ear, vasa auris internae (see Figs. 976 and 977). The single afferent vessel is the ***a. auditiva interna*** (see also p. 422) which enters the internal acoustic meatus along with the n. acusticus; there it divides into ***rami vestibulares*** and the ***ramus cochleae.*** The former pass with the single nerve branches to the sacculus, utriculus and the membranous semicircular canals, form a rich vascular net-work on the maculae acusticae and ampullae membranaceae and send branches to the lining of the spatium perilymphaticum; one of these branches goes over to the first third of the basal turn and anastomoses there with a branch of the ramus cochleae. The ***ramus cochleae*** enters the spindle, usually sends two branches to the rest of the basal turn, and by its terminal branch supplies the whole middle and apical turn; these branches run in the modiolus close to the origin of the lamina spiralis ossea and give off terminal branches continuously: 1. to the ganglion spirale cochleae, 2. into the lamina spiralis ossea as far as the organon spirale [Cortii] and 3. in the wall of the scala vestibuli as far as the lig. spirale cochleae. The ***vv. vestibulares*** collect the blood from the capillary domains of the semicircular ducts and the vestibular saccules; they form in largest part the delicate ***v. aquaeductus vestibuli,*** run in separate canals and empty into the sinus petrosus superior; a part of them open also into the v. canaliculi cochleae (see p. 856). The capillary domain of the lamina spiralis empties its blood through radial vessels in the ***vein of the spiral lamina*** which runs along the origin of the lamina spiralis and empties into the two spiral veins at the beginning of the basal turn.



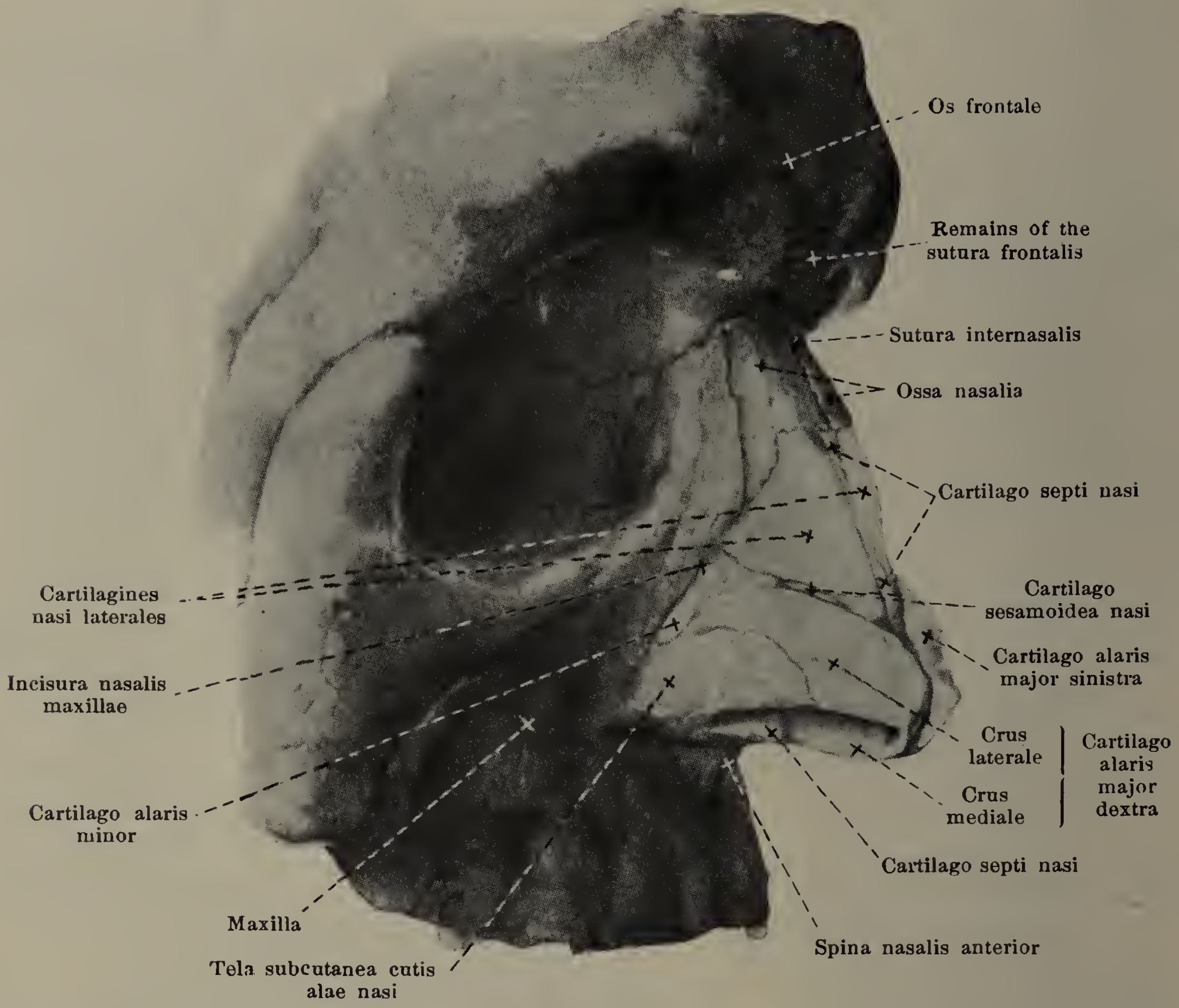
976. Blood vessels of the labyrinth of the right ear, somewhat schematic, viewed from the medial side (after description of F. Siebenmann).

Magnification: about 6:1.

(The bony capsule has been only partly removed from the cochlea.)


Bony capsule of the middle turn
Branch of the ramus cochleae a. auditivae internae
Vein of the spiral lamina
Scala vestibuli
Ganglion spirale cochleae
Bony capsule of the basal turn
Anterior spiral vein
Ductus cochlearis
Branch of the n. cochlearis
Modiolus
Ligamentum spirale cochleae
Vein of the spiral lamina
Scala tympani
Posterior spiral vein

977. Section through the basal and middle turns of the cochlea, schematic (after F. Siebenmann). Magnification: about 18:1.


Os frontale
Remains of the sutura frontalis
Sutura internasalis
Ossa nasalia
Cartilago septi nasi
Cartilago sesamoidea nasi
Cartilago alaris major sinistra
Crus laterale
Crus mediale
Cartilago alaris major dextra
Cartilago septi nasi
Spina nasalis anterior
Cartilagines nasi laterales
Incisura nasalis maxillae
Cartilago alaris minor
Maxilla
Tela subcutanea cutis alae nasi

978. Cartilages of the external nose, dissected out, viewed from the right and in front.

Blood vessels of the internal ear (continued) (see Figs. 976 and 977). The veins from the capillary region of the lig. spirale cochleae, from that of the ganglion spirale cochleae, and partly from the spiral lamina empty in the region of the basal and of a part of the middle turn into the *posterior*, otherwise into the *anterior spiral vein;* the afferent branches surround the scala tympani but in part also run along with the arteries in the wall of the scala vestibuli. The spiral veins together are spoken of as the *v. spiralis modioli,* and each of them lies on the basal wall of the scala tympani of the turn of the cochlea concerned; they both open into the conspicuous *v. canaliculi cochleae* (see p. 464). From the vein of the spiral lamina as well as from the spiral veins there is given off always a branch into the internal acoustic meatus, there to enter the large *vv. auditivae internae* (see p. 462) which receive tributaries mainly from the n. acusticus and the walls of the internal acoustic meatus.

The **Organ of Smell, organon olfactus,** lies in the *nose;* but this must also be regarded as belonging to the organs of respiration, the initial portion of which it forms.

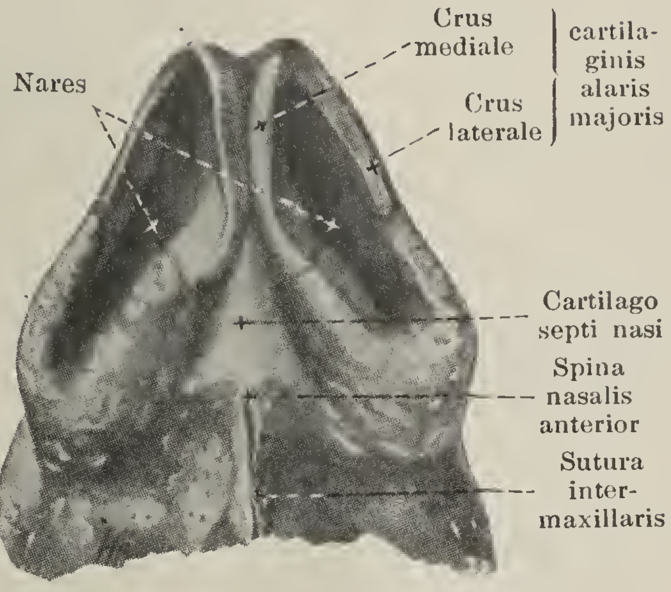
The **nose,** *nasus,* consists of the *external nose* and the *nasal cavity* with its *accessory cavities.*

The **external nose,** *nasus externus* (see also Figs. 564 and 979—983), has the shape of an irregular three-sided pyramid which is connected on its basal surface, *basis nasi,* with the skeleton of the face and at its margin projects from the region of the upper jaw. The upper narrow end which joins the forehead is called the *radix nasi, root of the nose;* from this the *dorsum nasi, back of the nose,* passes obliquely downward and forward to the *tip of the nose, apex nasi.* The lateral surfaces of the nose are fairly straight above; below they are more markedly curved, project more and are limited laterally by a sharp groove; this part is movable and corresponds to the *nasal wings, alae nasi,* the lower free margin of which, *margo nasi,* surrounds the *nasal openings, nares;* the latter are separated from one another by the most anterior, movable part of the nasal septum, *septum mobile nasi.*

979.

Cartilages of the external nose, dissected out,

viewed from below.

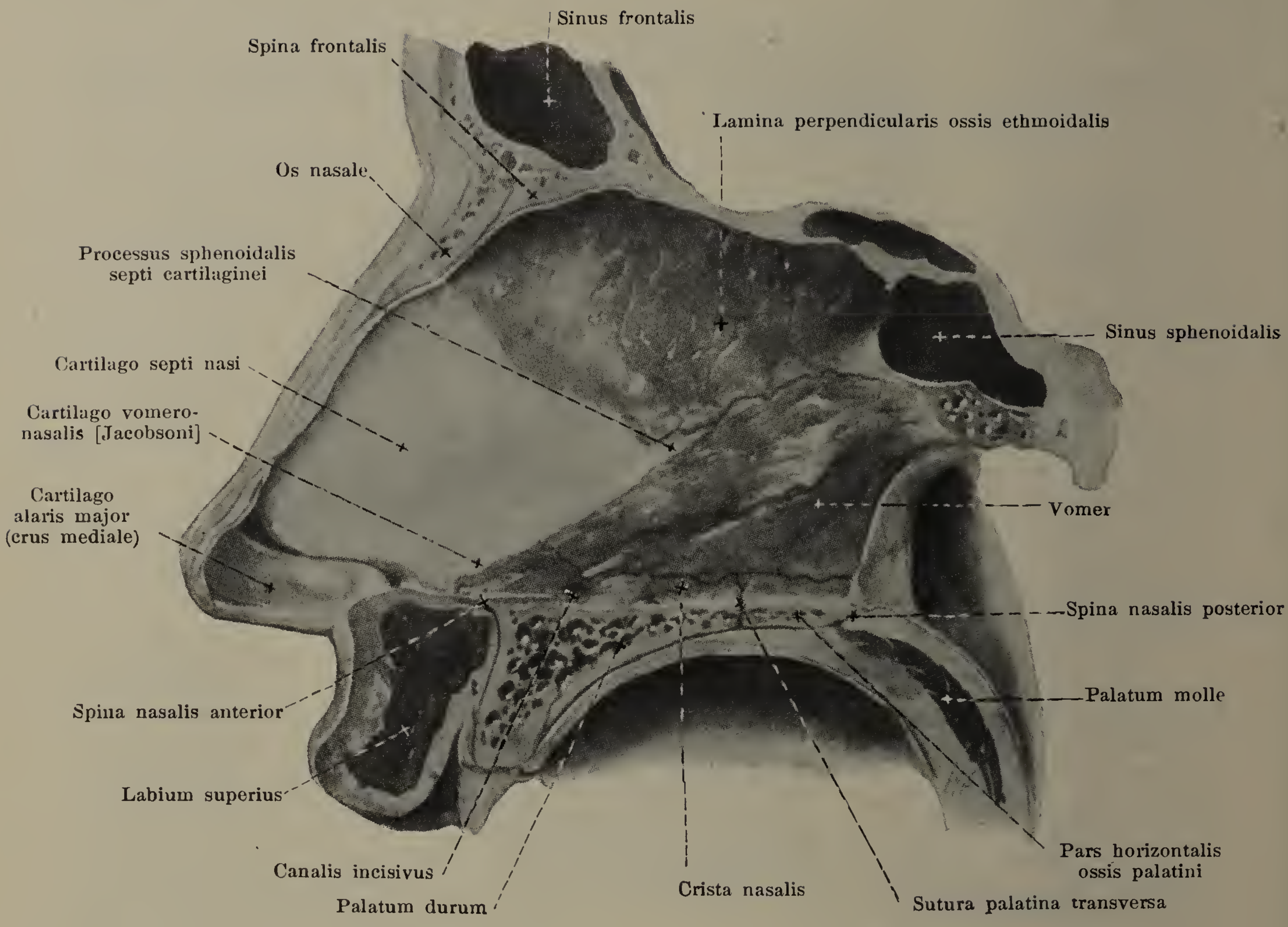


Nasus externus (continued) (see also Figs. 978 and 980—983). The framework of the external nose is formed by the nasal bones and by the *nasal cartilages, cartilagines nasi*, which consist of hyaline cartilage. Both are partly covered on the external surface by the nasal muscles, and by the external skin, while the inner surface is clothed by the mucous membrane of the nasal cavity. The nasal bones form only the upper, smaller part of the external nose; the cartilaginous and membranous part is attached directly to the apertura piriformis (see p. 64) and closes this completely with the exception of the nares.

The *cartilago nasi lateralis*, paired, is a thin, irregular triangular plate, which forms the middle part of the lateral wall. Its upper margin is shoved somewhat behind the nasal bone and the proc. frontalis maxillae and is attached to this by tough connective tissue; its inferior margin reaches partly as far as the cartilago alaris major; its medial margin fuses on the dorsum nasi partly with the anterior margin of the cartilago septi nasi. The *cartilago alaris major*, paired, is especially thin and of uncommonly variable development. It consists of two curved horse-shoe plates which go over into one another in front and which so surround the nares that the broader *crus laterale* may help to form the nasal wing and above is partly in contact with the cartilago lateralis and behind with a narrow thin process which may extend as far back as into the nasal wing, while the *crus mediale*, along with that of the other side passes for some distance backward in the septum mobile nasi and unites with this and with the cartilago septi loosely. The *cartilagines alares minores* are small, irregular pieces of cartilage which are found separated from the preceding in a variable number on each side in the posterior part of the nasal wing. The name *cartilagines sesamoideae nasi* is given to one or two very small pieces of cartilage which are situated on each side between the cartilago lateralis and the cartilago alaris major. In the posterior inferior portion of the nasal wing is a region of variable size which is free from cartilage; it is formed by a duplicature of the skin only.

The *cartilago septi nasi, septal cartilage* (see also Figs. 978 and 980), is an unpaired, median, irregular quadrilateral plate of cartilage which forms the anterior inferior part of the nasal septum and is inserted in the angle between the lamina perpendicularis oss. ethmoidalis and the vomer. The posterior superior margin is united with the lamina perpendicularis; the posterior inferior is laid in the groove of the vomer (see p. 28) and on the anterior part of the crista nasalis of the united maxillae. The anterior superior margin begins above behind the sutura internasalis and extends forward below as far as the dorsum nasi between the two cartilagines laterales, uniting with both above. The anterior inferior margin forms in front the upper boundary of the septum mobile nasi, reaches behind somewhat deeper and is attached there to the spina nasalis anterior. From the posterior angle a process of variable height, *processus sphenoidalis septi cartilaginei*, is inserted backward and upward into the anterior groove of the vomer (see p. 28), between it and the lamina perpendicularis oss. ethmoidalis, sometimes extending close to the sphenoid bone. The cartilage of the septum is, like the bony nasal septum (see p. 64), partly displaced to one side or the other. The *cartilago vomeronasalis [Jacobsoni]* (see Fig. 980) is a small strip of cartilage which lies close over the spina nasalis anterior on each side of the cartilago septi nasi (see also p. 859).

The external skin of the nose is very thin, is fastened above to the subjacent tissue by looser connective tissue free from fat, and to the nasal wings by tough connective tissue. Its hairs, especially toward the tip, are very fine. Its sebaceous glands, especially on the posterior part of the nasal wings are extraordinarily large. The skin is reflected at the nares upon the inner surface of the nose and at the limen nasi gradually goes over into the mucous membrane; it presents for some distance in the nares sebaceous glands and hairs which are here called the *vibrissae* and which may reach a considerable size.


Sinus frontalis
Spina frontalis
Lamina perpendicularis ossis ethmoidalis
Os nasale
Processus sphenoidalis septi cartilaginei
Sinus sphenoidalis
Cartilago septi nasi
Cartilago vomero-nasalis [Jacobsoni]
Vomer
Cartilago alaris major (crus mediale)
Spina nasalis posterior
Palatum molle
Spina nasalis anterior
Labium superius
Pars horizontalis ossis palatini
Canalis incisivus
Palatum durum
Crista nasalis
Sutura palatina transversa

980.

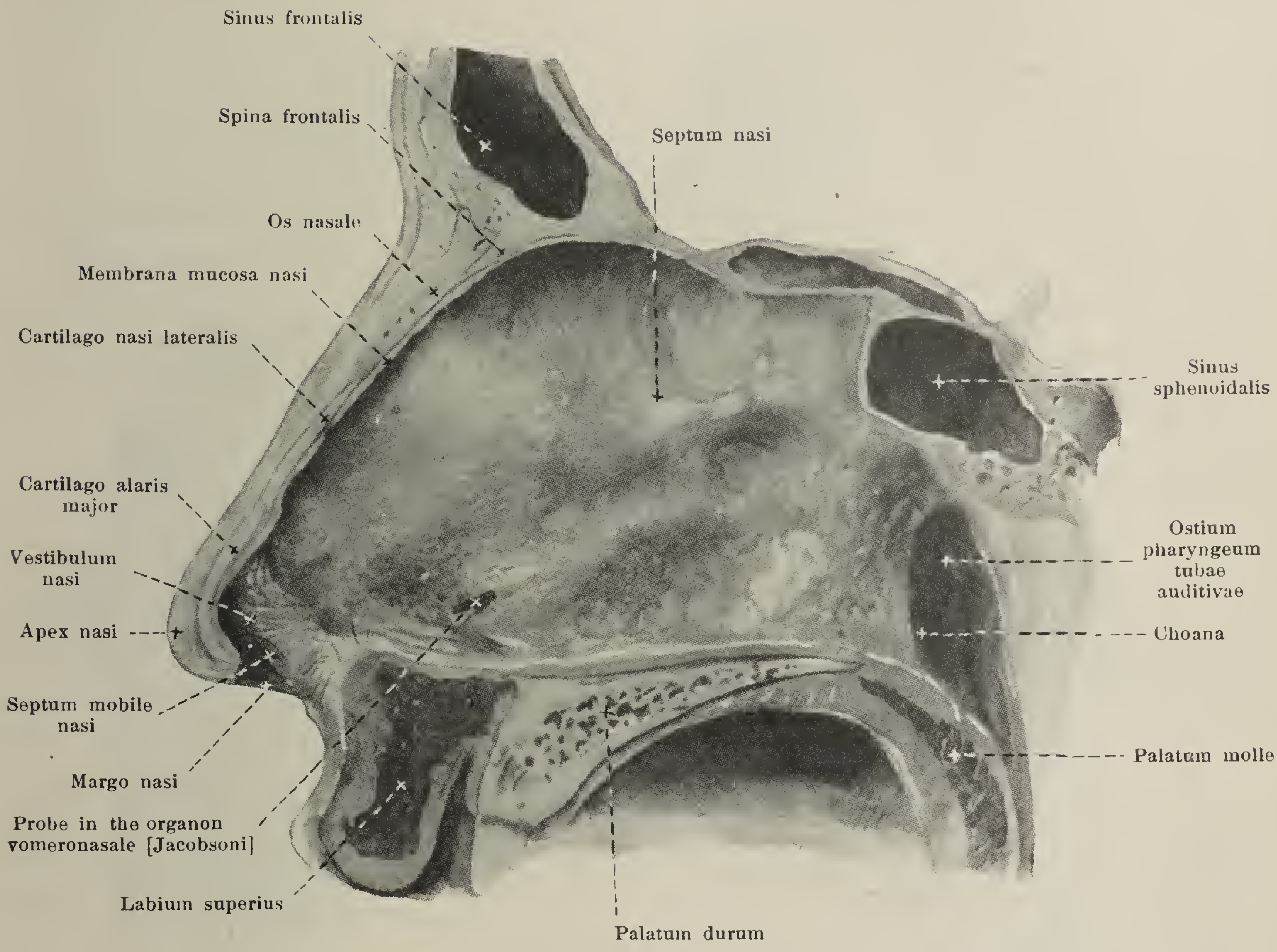
Nasal septum without the mucous membrane,

viewed from the left.

(Figs. 980 and 981 come from the same preparation, but are from a different head than that used in Figs. 982 and 983.)

The ***nasal cavity, cavum nasi*** (see also Figs. 76—78, 568, 600, 601 and 981—984), is bounded by the inner surface of the external nose and by bone (see p. 62). It opens in front through the *nares, nasal openings,* bordered only by skin and situated on the inferior surface of the external nose; they are of very variable form and are somewhat obliquely placed. Behind, the nasal cavity communicates with the pharynx through the two adjacent, quadrilateral *choanae* (see p. 62). It is divided into two approximative symmetrical halves by the medianly-placed *nasal septum, septum nasi,* which usually deviates somewhat to one side. The upper and posterior part of the septum is bony and is called the *septum nasi osseum* (see p. 64); the anterior part is formed by the cartilago septi nasi (see p. 857) and is called the *septum cartilagineum;* attached to this in front and below is the *septum membranaceum* which lies between the two nares, contains the crura medialia of the cartilagines alares majores and is also designated the septum mobile nasi (see p. 856).

The walls of the nasal cavity are lined by mucous membrane, *membrana mucosa nasi.* This is of fairly even thickness and is markedly thicker only upon the middle and inferior turbinated bones. It repeats therefore on the whole the form of the nasal cavity and its (cartilaginous and bony) walls, which have already been exactly described on pp. 62—64, the only difference being that the air-containing inner spaces are more or less narrowed.



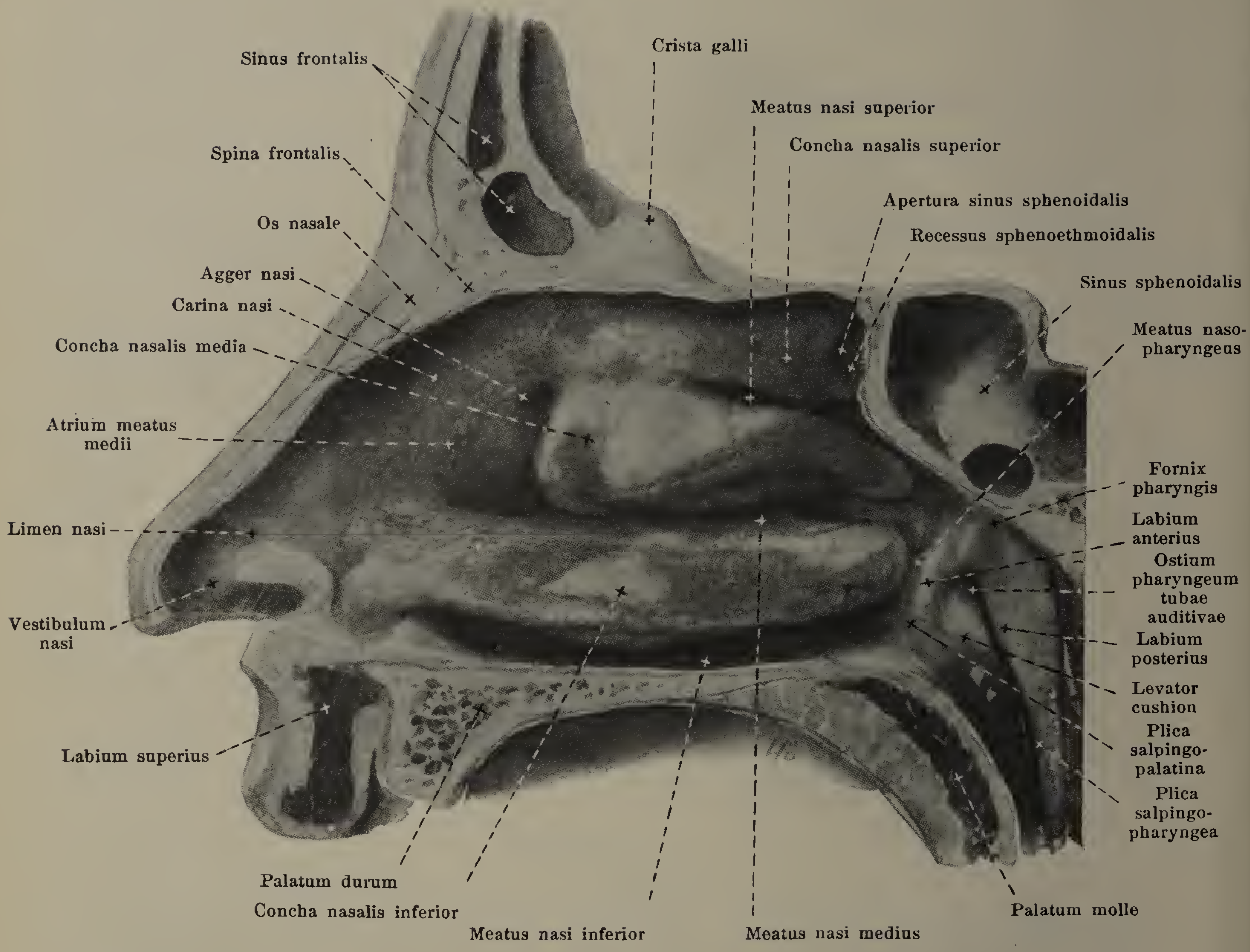
981. Nasal septum with the mucous membrane intact, viewed from the left.

(Figs. 980 and 981 have been taken from the same preparation, though from another head than that used in Figs. 982 and 983.)

Nasal cavity (continued) (see also Figs. 76—78, 568, 600, 601, 980 and 982—984). The space, which is enclosed by the movable nasal wings is called the *vestibule, vestibulum nasi;* it is marked off above from the nasal cavity proper by a distinct ridge on the lateral wall, *limen nasi*, which projects from the upper margin of the cartilago alaris major.

The *septum nasi* is evenly covered by mucous membrane. A little above the spina nasalis anterior it presents very often a fine opening which leads into a short canal ending blind and passing backward directly upon the cartilago septi, the *organon vomeronasale [Jacobsoni];* this with the cartilago vomeronasalis [Jacobsoni] (see p. 857) forms the homologue of a larger structure constant in a large series of animals to which (in these animals) fibres of the nn. olfactorii can be followed. Below and behind this opening in the floor of the nasal cavity there is often a pin-point-like opening which leads into a canaliculus, the *ductus incisivus* (not illustrated); this enters the canalis incisivus and usually ends blind, though it may open by a very fine unpaired opening upon the papilla incisiva of the palate (see p. 517); it is the rudiment of *Stenson's passage*, so well developed in many mammals.

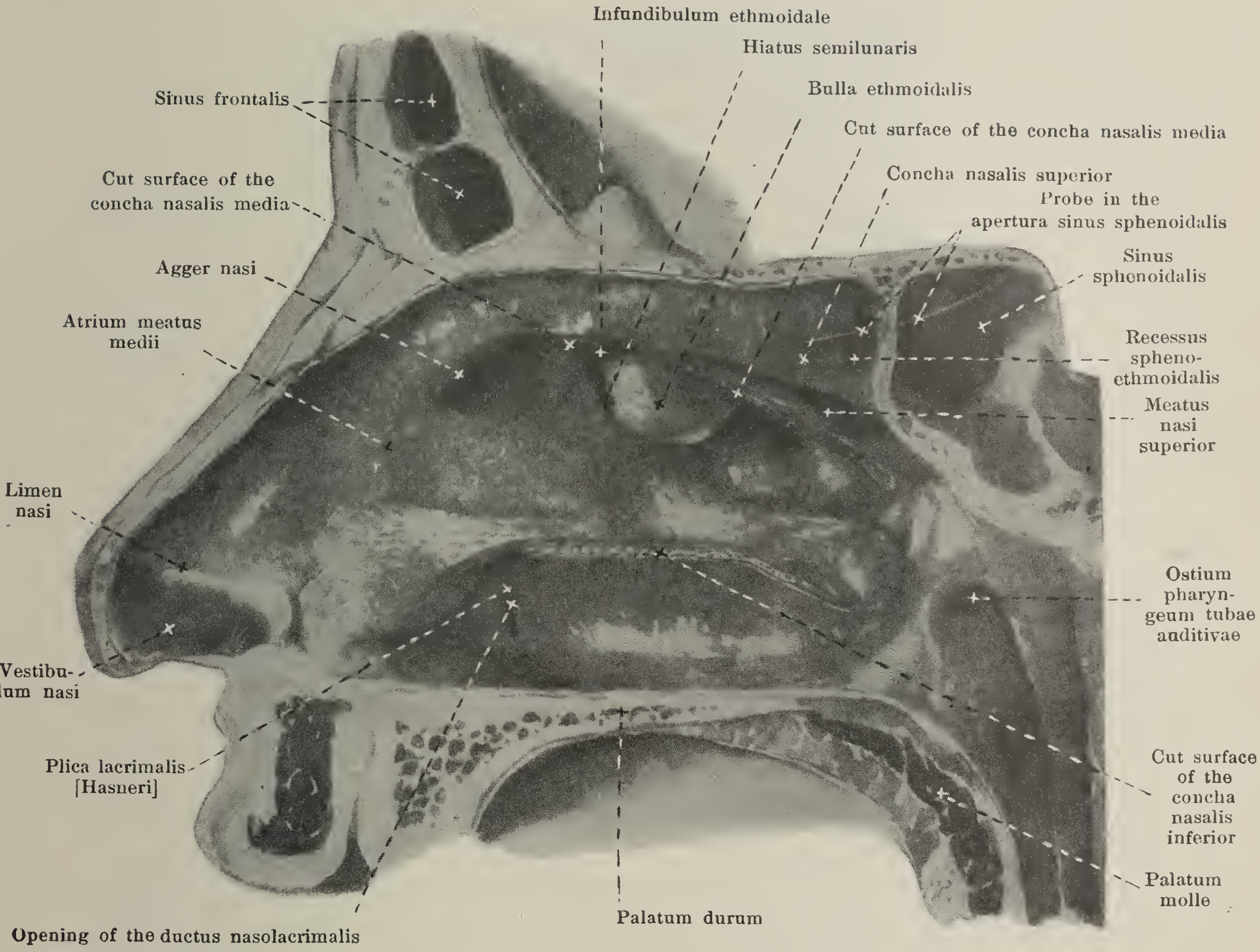
The narrow superior and the broad inferior walls are covered by smooth mucous membrane.



982. Right wall of the nasal cavity with the mucous membrane, viewed from the left.

(Figs. 982 and 983 are from the same preparation though from another head than Figs. 980 and 981.)

Nasal cavity (continued) (see also Figs. 76—78, 568, 600, 601, 980, 981, 983 and 984). The lateral wall presents free turbinated bones, *nasal mussels* (usually four, sometimes three), *concha nasalis inferior, media, superior, suprema,* and also below each and lateral from it (see also Fig. 568) the corresponding *nasal meatus, meatus nasi inferior, medius, superior* and *recessus sphenoethmoidalis* (see pp. 62 and 63). The inferior concha arises in front very gradually from the wall; it and the lower meatus are longest, the upper concha and upper meatus shortest. The middle concha hangs down valve-like from its insertion for quite a distance (especially in front) and ends in front in an approximately vertically-placed free margin from the upper end of which extending downward in a curve is a small ridge, *agger nasi;* this bounds from above a slightly depressed area, *atrium meatus medii,* which reaches below as far as the upper margin of the inferior nasal concha and gradually goes over backward into the middle meatus. The narrow space situated between the agger nasi and the inner dorsum of the nose and which extends obliquely upward and backward as far as the upper wall of the nasal cavity is called the *carina nasi.* Concerning the *recessus sphenoethmoidalis* and *meatus nasi communis* see pp. 62 and 63. The *meatus nasopharyngeus* (see also p. 62) is in the nasal cavity, covered by mucous membrane, bounded lateralward by a narrow groove situated behind the posterior end of the middle and inferior conchae: dorsalward from this is the labium anterius of the ostium pharyngeum tubae auditivae (see p. 523) and an elevation, *plica salpingopalatina,* which passes to the soft palate.

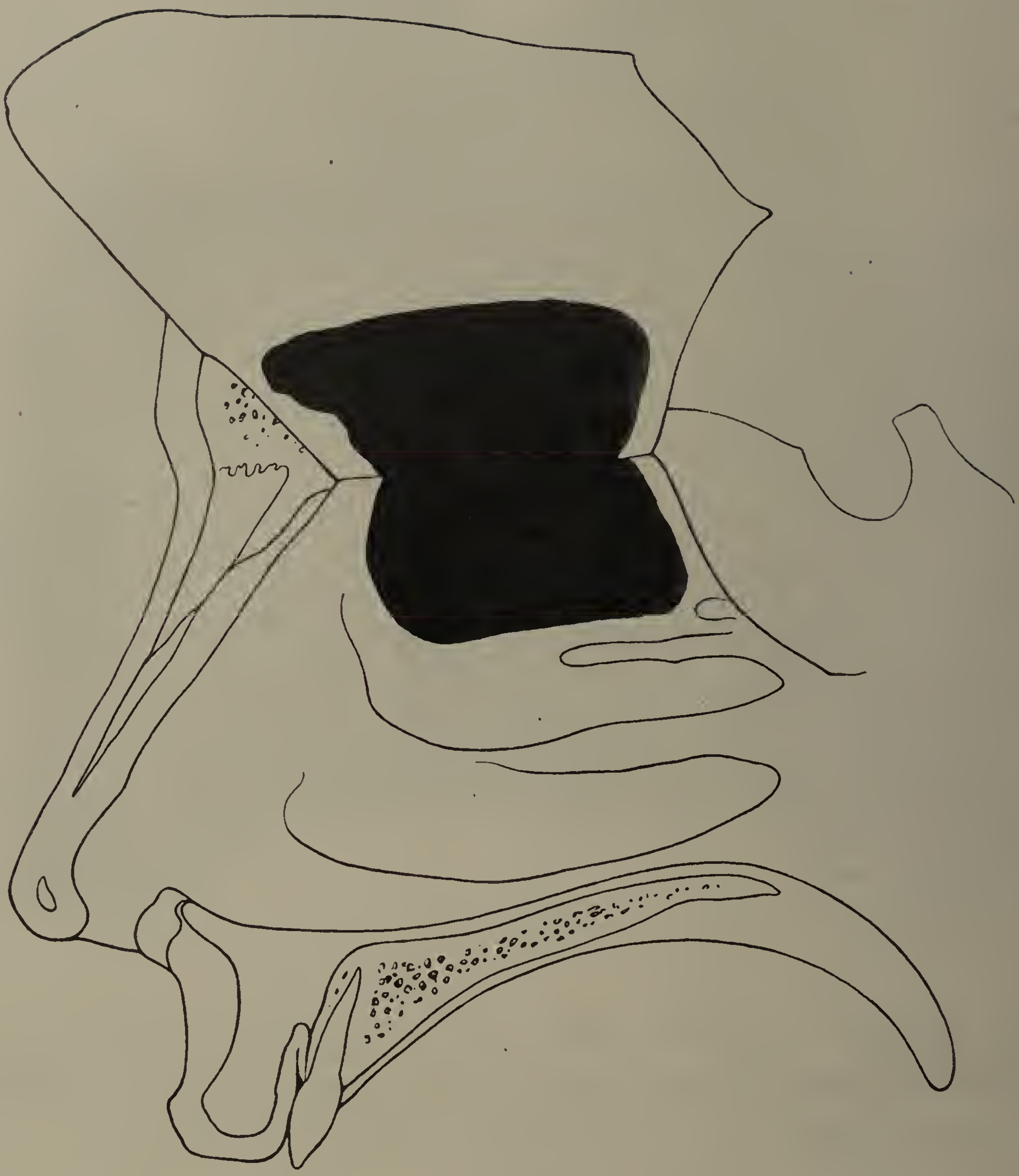

Infundibulum ethmoidale
Hiatus semilunaris
Bulla ethmoidalis
Cut surface of the concha nasalis media
Concha nasalis superior
Probe in the apertura sinus sphenoidalis
Sinus sphenoidalis
Recessus spheno-ethmoidalis
Meatus nasi superior
Ostium pharyngeum tubae auditivae
Cut surface of the concha nasalis inferior
Palatum molle
Palatum durum
Opening of the ductus nasolacrimalis
Plica lacrimalis [Hasneri]
Vestibulum nasi
Limen nasi
Atrium meatus medii
Agger nasi
Cut surface of the concha nasalis media
Sinus frontalis

983. Right wall of the nasal cavity with the mucous membrane after removal of the middle and inferior conchae, viewed from the left.

(Figs. 982 and 983 come from the same preparation though from another head than Figs. 980 and 981.)

Nasal cavity (continued) (see also Figs. 76—78, 568, 600, 601, 980—982 and 984). The essentials concerning the *accessory cavities of the nose*, *sinus paranasales*, and their communications with the nasal cavity have been mentioned on pp. 6, 19, 23, 30 and 62. The opening of the sinus frontalis is found in the upper part of the infundibulum ethmoidale. The sinus maxillaris opens also usually in the infundibulum ethmoidale, and through the hiatus semilunaris (see p. 63) in the middle nasal meatus; sometimes behind and below this main opening an accessory opening exists, also in the middle meatus, which corresponds to the spot free from bone, situated behind the proc. uncinatus (see Fig. 77). The ductus nasolacrimalis opens in the inferior nasal meatus (see p. 822).

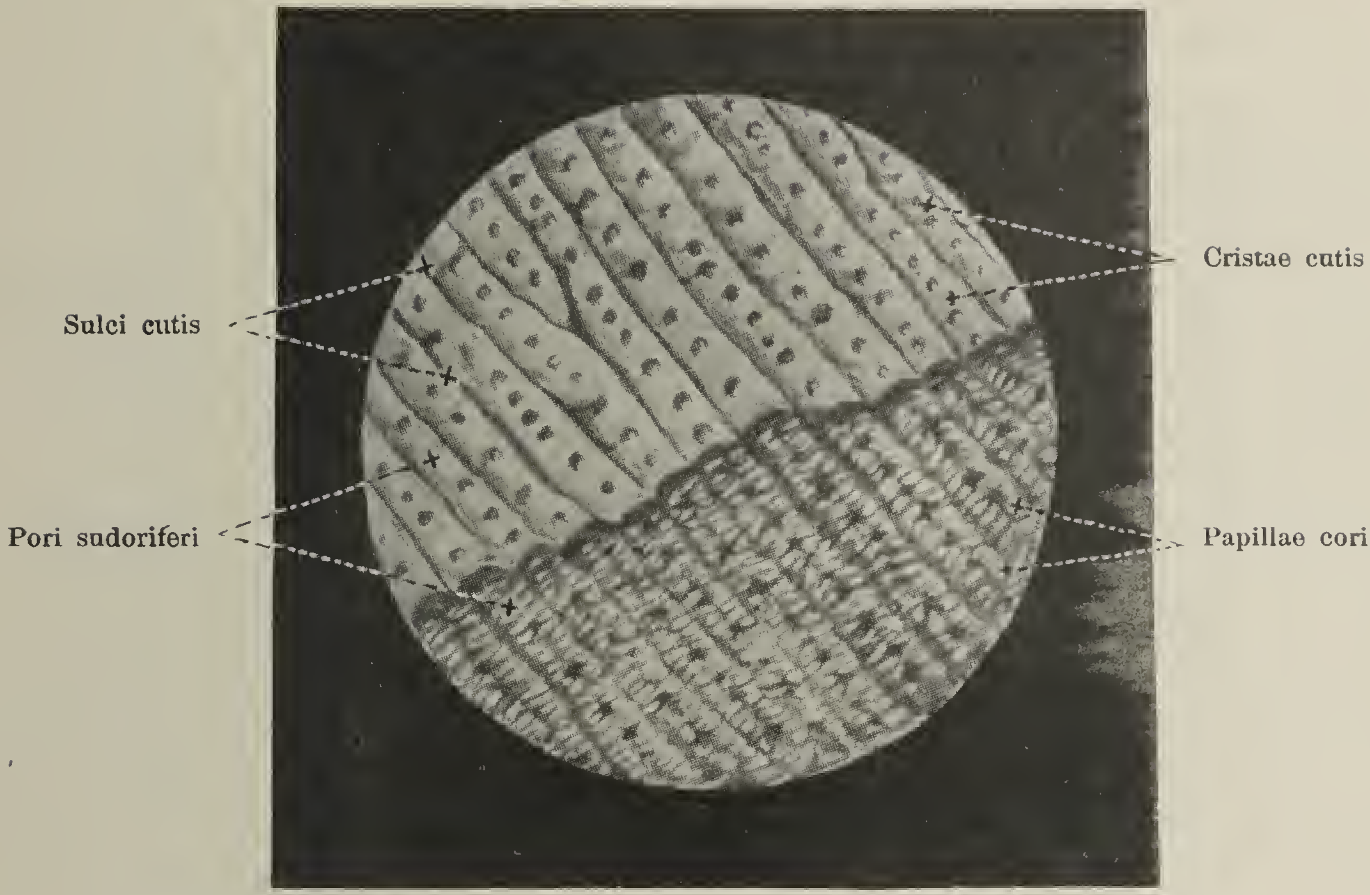
The *nasal mucous membrane, membrana mucosa nasi* (see also p. 858), is continuous in front with the skin of the face (see p. 857), at the choanae with the mucous membrane of the palate and of the pharynx. In the nasal cavity proper, it is firmly attached to the periosteum of the bone and to the perichondrium of the cartilage, and is studded with numerous glands, *glandulae nasales.* It presents in its tela submucosa numerous venous networks, which are developed to form very thick erectile tissue plexuses, *plexus cavernosi concharum,* on the middle and inferior conchae and are the cause of the marked thickness of the mucous membrane in these places. The mucous membrane is continued into all the accessory cavities and lines their walls as a very thin membrane, poor in glands.



984. Extent of the true olfactory mucous membrane (after Effie A. Read).

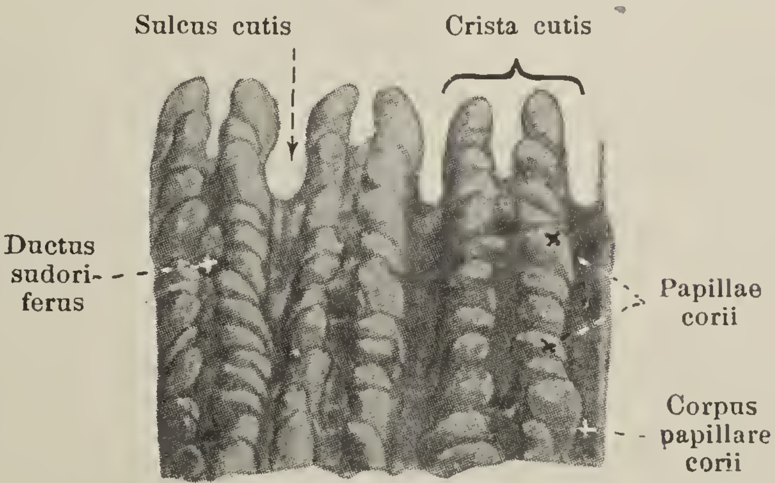
(The nasal septum has been reflected upward and the regio olfactoria on it and on the lateral wall indicated in black.)

Nasal cavity (continued) (see also Figs. 980—983). The mucous membrane is of a reddish color, of variable shade. A large region of the concha suprema and concha superior and a corresponding portion of the septum is characterized even macroscopically by a brownish color-tone; it is at the same time somewhat thicker, contains the terminations of the nn. olfactorii in an especially constructed epithelium and is called the *regio olfactoria;* it is characterized by long tube-like glands, *glandulae olfactoriae.* This part of the mucous membrane alone can be designated the *olfactory organ, organon olfactus,* in the strict sense. The rest of the mucous membrane is distinguished from it as the *regio respiratoria.*



985. Skin ridges and papillae in the sole of the foot. Magnification: 8:1.

(In the upper part the epidermis has been partly macerated off, in the lower part completely.)



986. Papillae of the skin of the sole of the foot. Magnification: 21:1.

(The epidermis has been completely removed.)

The **external skin**, *integumentum commune*, an external sheath for the body of about 1.6 sq. meters in extent, covers the whole surface and at the opening of the respiratory, digestive, urinary and sexual passages, goes over uninterruptedly into the mucous membranes. It is divisible into the skin in the stricter sense, *cutis*, and its accessory structures, ***hairs***, ***pili***, and ***nails***, ***ungues***, which are products of the epidermis just as are the *cutaneous glands, glandulae cutis*, which are situated in the cutis.

The *cutis* (see Fig. 993) consists of two parts sharply separable from one another in their development and in their structure, an epithelial part, the *epidermis, scarf-skin,* and a part consisting essentially of connective tissue, which is farther subdivisible into the *corium, leather skin,* and the *tela subcutanea, subcutaneous tissue.*

The *epidermis, scarf-skin* (see also Fig. 993), consists of a lamellated epithelium and forms the external visible surface of the skin; it covers the corium directly and completely and sinks into its depressions. Its thickness varies in different individuals and is also very variable in the same individual; in the sole of the foot it measures about 2 mm in depth, in the palm of the hand about 1 mm and elsewhere varies between 0.07 and 0.17 mm. In white races the epidermis contains a little pigment (except in the non-pigmented albinos); in colored races there is much pigment.

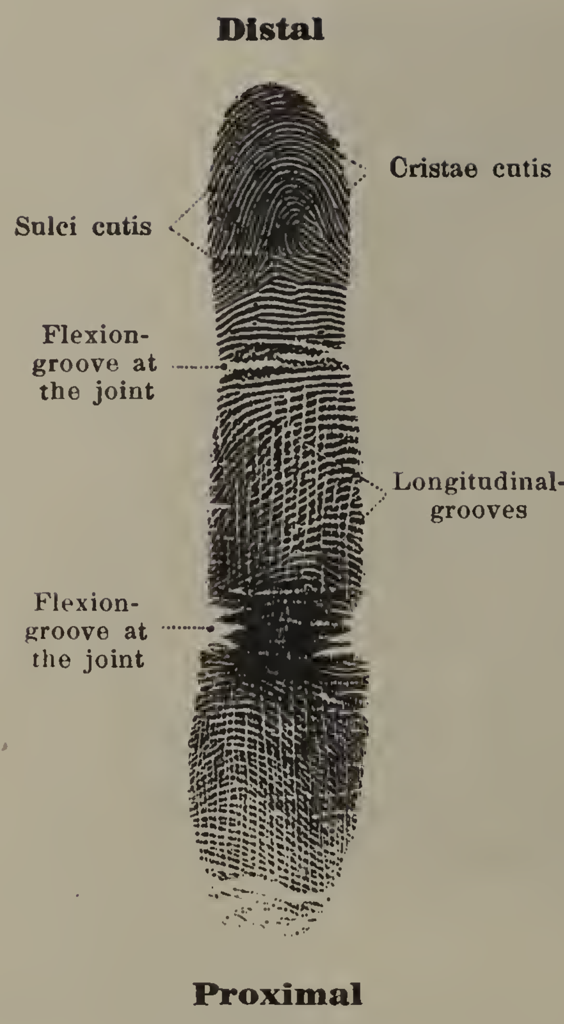


Fig. 987.

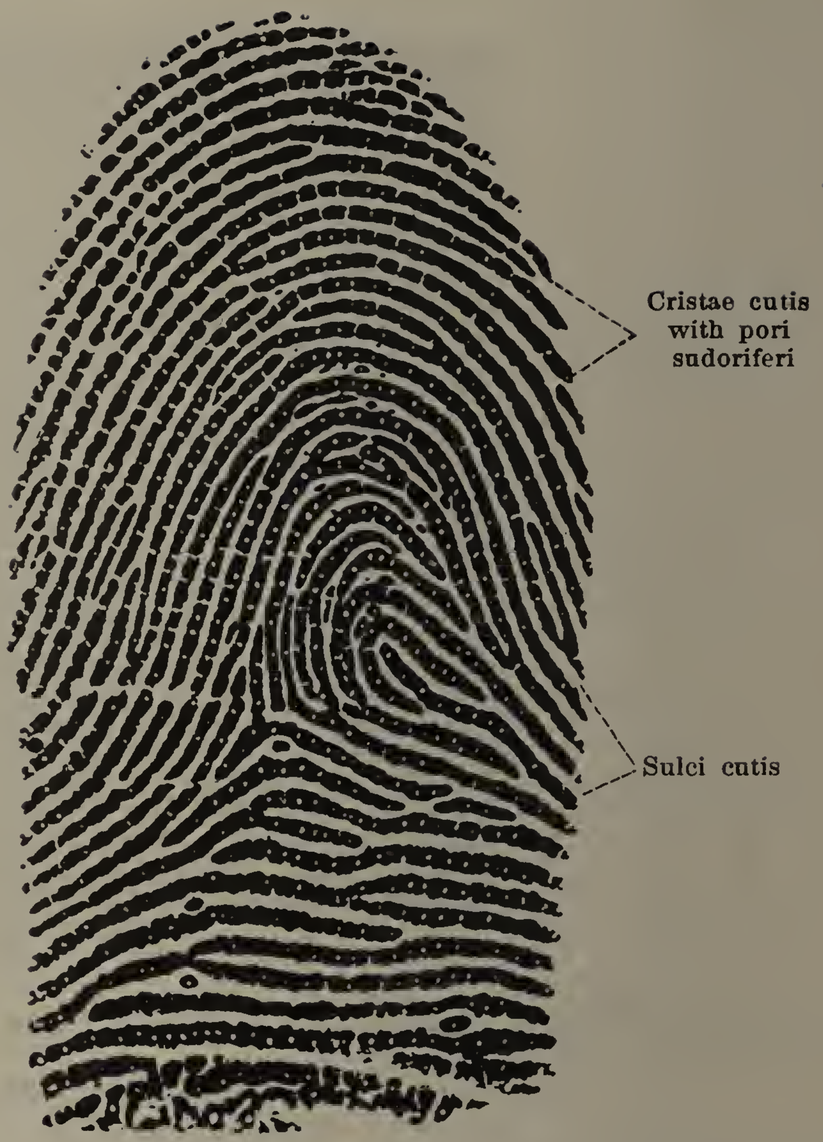


Fig. 988.

987 and 988. Ridges and sulci in the skin of the volar surface of a finger of the right hand,

obtained by impression.

Natural size. Distal part of Fig. 987, magnified 4 times.

The *corium, leather skin* (see Figs. 985, 986, 993 and 994), consists of a close plexus of bundles of connective tissue along with elastic fibres and smooth muscle fibres. The connective tissue bundles, especially in the deeper layers, are usually directed only a little obliquely toward the surface, run nearly parallel to it and as they go are interwoven with one another as in straw-matting; corresponding to the permanent or often repeated tension which usually is exerted upon them from their surroundings, certain particular directions are preferably followed by them and the bundles parallel to these directions are more tightly stretched than those perpendicular to them; accordingly wounds which are situated in the direction of the tighter stretching gape less than those directed perpendicular to it. The smooth muscles are found usually in connection with the hair follicles, but may be spread out in a surface as in the tunica dartos; but in the latter case it belongs to the tela subcutanea.

The thickness of the corium varies according to race, sex (somewhat thicker in the male than in the female), age (much thinner in the child than in the adult) and individually; it also varies in the same body in different places: it is thinnest in the eyelids and in the genitalia (0.3—0.6 mm), thickest on the back, buttock, palm and sole (2—3 mm).

The surface of the corium turned toward the epidermis is studded by microscopically small thread-like or cone-like processes, *papillae.* They, together with the more superficial layer of the corium from which they project, are spoken of as the *corpus papillare* and consist of especially closely interwoven fine connective tissue fibres; the other, larger part of the corium which is more loosely woven of coarser bundles is called the *tunica propria.* The papillae in different parts of the body are of different length, form and frequency; they are absent only in a few places (forehead, external ear, perineum, parts of the scrotum and of the axilla); the longest (0.1—0.2 mm) are found in the palm and sole.

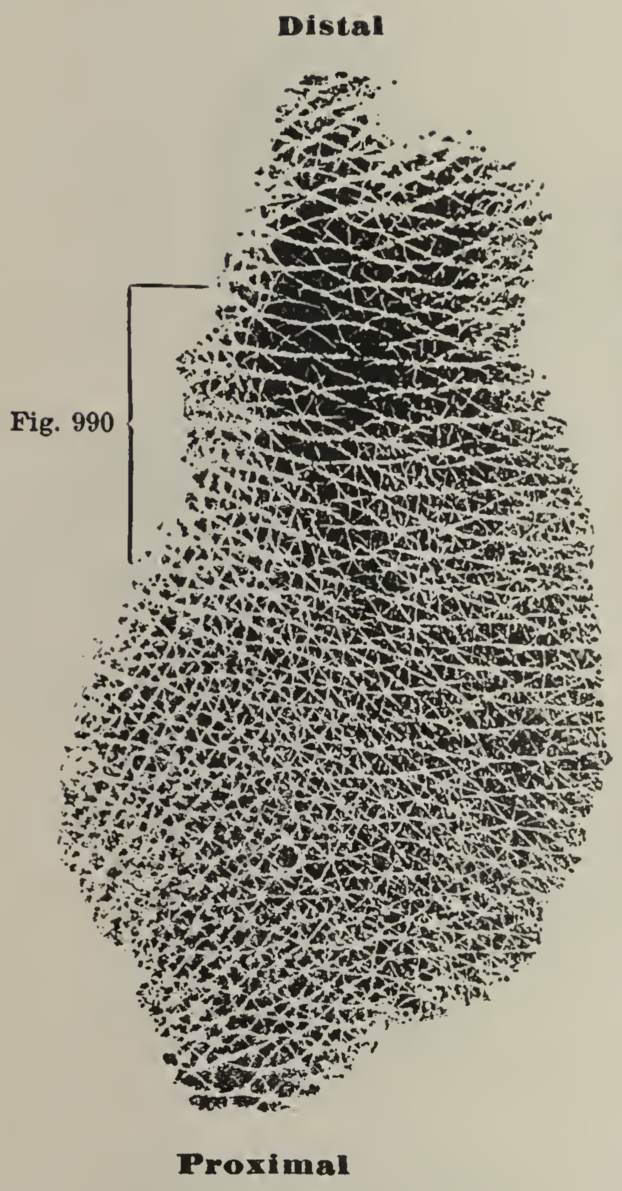


Fig. 989.

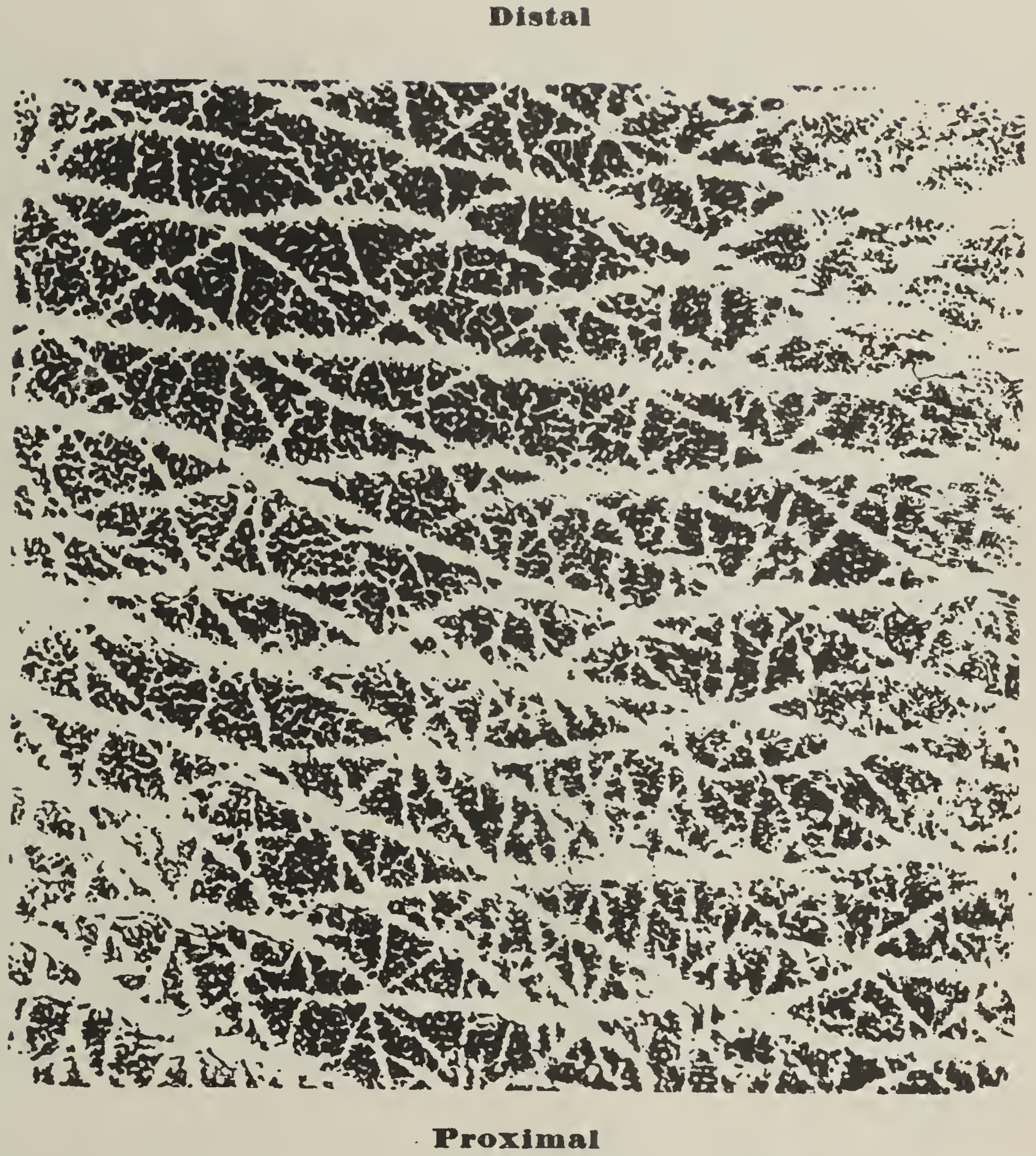


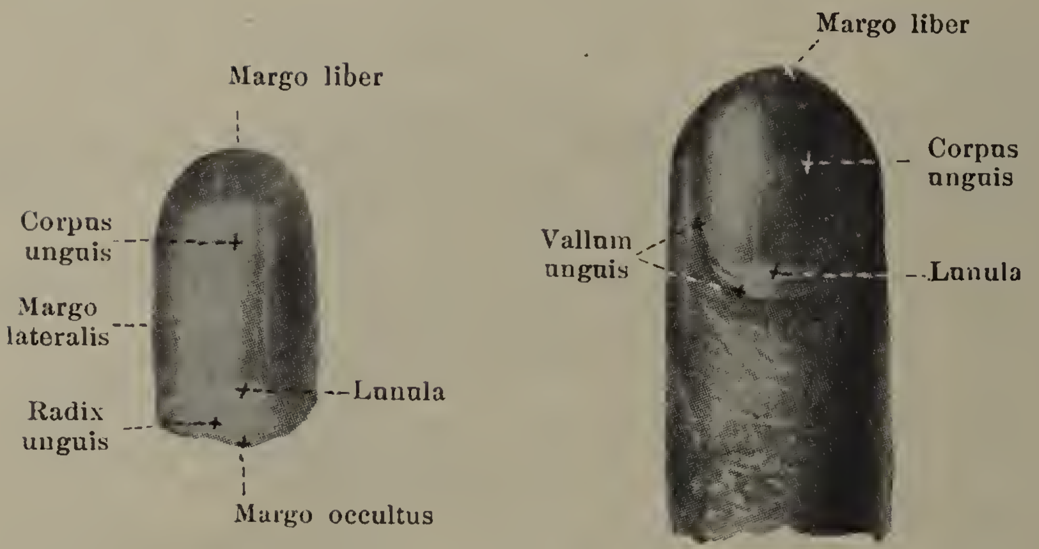
Fig. 990.

989 and 990. Skin sulci and cutaneous areals on the surface of the back of the left hand (ulnar portion), obtained by impression.

Natural size. The area in the bracket in Fig. 989 is here shown magnified 4 times.

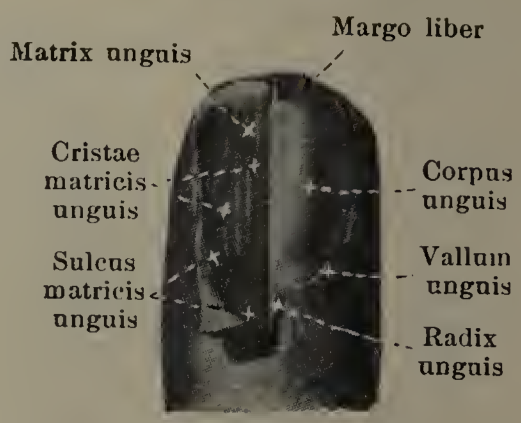
(The hairs were shaved off before the impression was taken; they emerge in the middle of the stellate white figures distinctly visible especially in the proximal part of Fig. 989.)

The *papillae* (continued) (see also Figs. 985—988 and 992—994) project into the lower layers of the epidermis and very often cause corresponding smaller hillock-like projections on the surface of the epidermis. When this is not the case, the surface of the epidermis looks smooth and the presence of the papillae appears first on cross-section. In other cases even on the free surface a delicate marking can be seen which depends upon the fine *cutaneous sulci*, *sulci cutis*, and the groups of papillae projecting slightly above the surface situated between them. This marking is very variable in different parts of the body, and in part also shows great individual variation (especially in the fingers). In the palm and the fingers, in the sole of the foot and in the toes the papillae are arranged in rows, but the epidermis does not sink in near each one of them but forms small wall-like *cutaneous ridges*, *cristae cutis*, of which each regularly covers over two rows of papillae and is separated from the next by a groove-like cutaneous sulcus (see above); the sweat glands open at the top of these cutaneous ridges and enter into the corpus papillare in the groove between the two corresponding rows of papillae.



991. Fingernail, viewed from the dorsal surface,

isolated. in situ.



992. Fingernail and bed of nail, viewed from the dorsal surface.

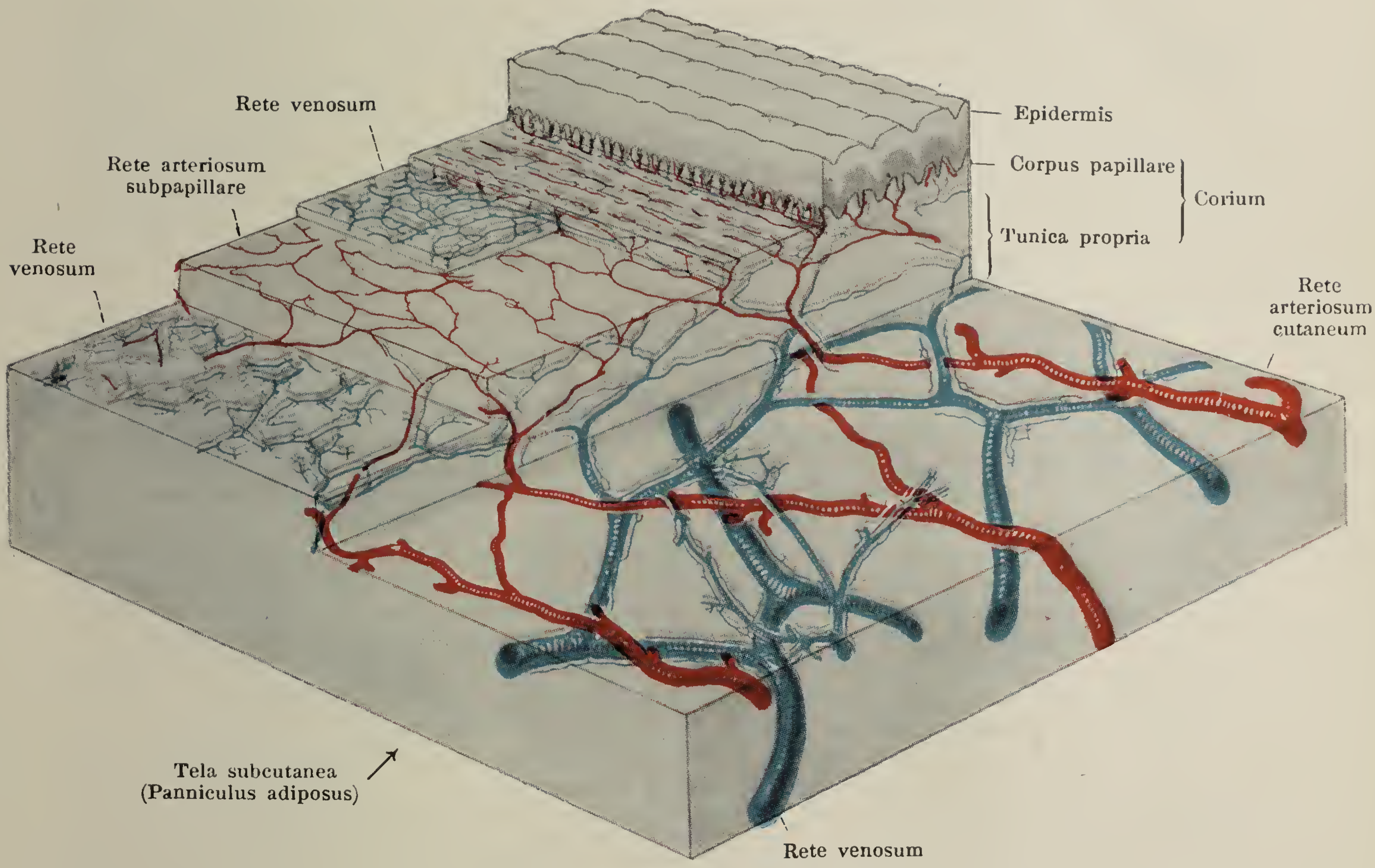
(The left half of the nail has been removed.)

The *tela subcutanea, subcutaneous tissue* (see Fig. 930), is not sharply separated from the corium but passes out of it without sharp limit; it is distinguishable from the corium by the greater thickness and looser interweaving of the bundles of connective tissue as well as by the fact that it may contain fatty tissue in a very variable way, arranged in smaller or larger lobules. When the fat is abundant the subcutaneous tissue is called the *panniculus adiposus;* the connective tissue septa between the lobules may then become thickened to form a septal wall, parallel to the surface, which divides the fat into two layers. The subcutaneous tissue everywhere unites the corium with the deeper-lying structures; the more sharply limited tougher connecting bands between these and the corium are called *retinacula cutis* (see also p. 636).

The *hairs, pili*, are found upon the whole surface of the body except the red border of the lips, the palms of the hands, the soles of the feet, the dorsal surfaces of the endphalanges of the fingers and toes, the nipples of the breast, the glans penis and the inner surface of the praeputium, as well as the labia minora pudendi and the vestibulum vaginae; they are epidermoidal structures and project into the corium or into the subcutaneous tissues. They usually stand obliquely to the surface and in definite directions varying according to the region of the body and thus form *hair-streams, flumina pilorum*, and *hair whirlpools, vortices pilorum* (not illustrated), which are more distinct in embryos than in adults. The hairs are of very different length and thickness; they include the *capilli (hairs of the head), supercilia (hairs of the eyebrows), cilia (eyelashes), barba (hairs of the beard), tragi (hairs of the ear), vibrissae (hairs of the nose), hirci (axillary hairs)* and *pubes (pubic hairs);* the very fine hairs found on other parts of the body are together spoken of as *lanugo (woolly hairs).*

The *nails, ungues,* are quadrilateral, curved plates consisting of horny cells of the epidermis which end distalward in the *margo liber.* Their lateral margins, *margines laterales,* and their proximal sharpened margin, *margo occultus,* are enclosed in a groove-like depression of the cutis, the *ungual fold, sulcus matricis unguis,* and are overlaid on the surface by the *ungual wall, vallum unguis.* The main mass of the nail, *corpus unguis,* rests upon the *bed of the nail, matrix unguis,* which is beset with numerous longitudinal ridges, *cristae matricis unguis.* The generation of the nail substance takes place at the proximal part hidden beneath the ungual wall, which accordingly is called the *root of the nail, radix unguis,* this part consists of cells which are not yet hornified and not yet dry, and is recognizable by its whitish color; it often projects beyond the distal end of the ungual wall as a small sickle-shaped area, the *lunula.*

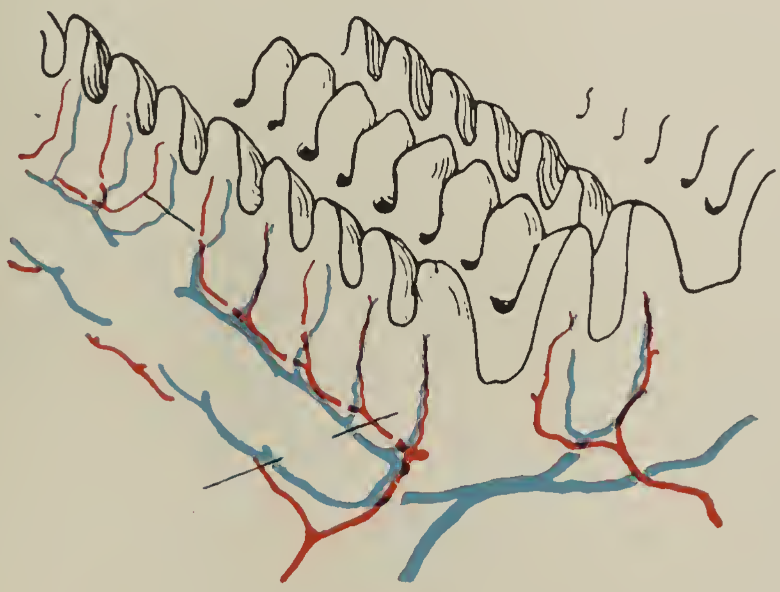
The *glands of the skin, glandulae cutis,* occur in two varieties, *glandulae glomiformes, coil glands,* and *glandulae sebaceae, sebaceous glands.* To the former belong the *glandulae ciliares [Molli]* (see p. 821), the *glandulae ceruminosae* (see p. 832), the *glandulae circumanales* (especially large sweat glands in the immediate neighborhood of the anus) and the *glandulae sudoriferae, sweat glands.* The latter (see Fig. 930) consist of a simple tubule, which by a coil-like rolling up of its blind end forms the spherical gland-body, *corpus glandulae sudoriferae.* This lies in the subcutaneous tissue or in the corium and sends its excretory duct, *ductus sudoriferus,* perpendicular to the surface, where it opens by a small rounded opening, *porus sudoriferus,* at the top of the cristae cutis where these are present (see p. 865).



993. Distribution of the blood vessels in the skin of the sole of the foot, in a staircase-like model.

Magnification: about 12:1.

(The sweat-glands and their vessels have not been illustrated; only the uppermost part of the subcutaneous tissue is shown.)



994. Distribution of the blood vessels in the corpus papillare of the corium. Magnification: about 40:1.

(The epidermis is not shown.)

Glands of the skin (continued). The sweat glands vary greatly in size and number. They are most numerous in the palm of the hand and sole of the foot, where in one square centimeter about 1000 are counted; they are absent only from the red part of the lips, from the glans penis, from the internal surface of the praeputium and from the vestibulum vaginae.

The *sebaceous glands, glandulae sebaceae* (see Figs. 565 and 930), are simple flask-like or manifoldly bulged sacks which lie in the cutis and, as a rule, appear as appendages of the hair follicles; they secrete the *sebum cutaneum.* They, like the hair, are absent from the palm of the hand and the sole of the foot. They are everywhere of about the same size; the largest of them are found in connection with the very fine woolly hairs in the skin of the external nose. They are found entirely independent of any connection with hair follicles on the red part of the lips and on the glans penis.

Blood vessels of the external skin, vasa sanguinea integumenti communis (see Figs. 993 and 994). The arteries which enter the skin are destined to supply this exclusively or they are branches of the arteries to the muscles. Their number and their diameter are different for the surface unit in different places; they are larger in those places which are frequently exposed to external pressure (for instance palm of hand, sole of foot, regio glutaea). These arteries pass through the subcutaneous connective tissue, anastomose with one another in the lowermost layer of the corium and form there a leaf-like cutaneous network, *rete arteriosum cutaneum,* the concentration of which varies in the same way as do the number and diameter of the tributary branches. The vessels supply the superficial fat layer and the sweat glands by means of finer twigs. From this network proceed branches which form in the upper third of the corium a second laminar network, the *subpapillary network, rete arteriosum subpapillare,* and from this arise minute twigs, which do not anastomose with one another (end-arteries); they run in the sole of the foot, usually a short distance in the direction of the rows of the papillae, and finally send off smallest twigs into the papillae; from the subpapillary network go off also the branches to the hair follicles and the sebaceous glands.

The blood arising from the capillaries of the papillae passes through several venous networks, *retia venosa,* of which the uppermost is situated close beneath the rows of papillae, the lowermost, largest, at the junction between the corium and the subcutaneous tissues; between these two, in the sole of the foot, still two other networks are interpolated. These networks receive also the small veins from the hair follicles, the glands and the fatty tissue. The veins run only partly beside the arteries. From the deepest network larger trunks enter the subcutaneous tissue and open usually into the large veins of the skin (venae cutaneae).

A.

Index.

(The numbers always refer to pages; the references to the figures will be found there in the text. Exceptionally a name may not be mentioned in the text, in which event the figure to be found upon the page referred to is meant.)

Latin words with several syllables bear above the vowel of their last syllable but one (if it was considered necessary also of the other syllables) a sign of length to denote their correct accentuation.

Thus the accentuation of words with 3 and more syllables is governed by the following 2 rules:

1. The last syllable but one is to be accented, if the vowel of this syllable is long.
2. The antepenult is to be accented, if the vowel of the last but one syllable is short.

Of dissyllables the last syllable but one is to be accented.

A.

Abdominal part of the sympathicus 790.
— rings 291, 298, 301.
Abdūctor minĭmi digĭti 336, 371.
— pollĭcis 336.
Accelerātor urīnae 630.
Accessorĭus or flexor accessorĭus digitōrum pĕdis 372.
Accessory muscle to the iliocostal 309.
Accessory organs of the eye 797.
Acetabŭlum 129.
Acrōmĭon 101.
Acromiothoracic axis, or thoracic axis 424.
Adĭtus ad ăquaedūctum cerĕbri [666.
— glōttĭdis 576.
— lărȳngis 576.
— orbĭtae 59.
Admĭnĭcŭlum līnĕae ālbae 297.
Aequātor bulbi ŏcŭli 795.
— lentis 806.
After brain 645.
Agger nāsi 860.
Air sacs 585.
Āla cĭnĕrĕa 650.
— ŏssis īlĭum 129.
Ālae lŏbŭli centrālis 653.
— magnae oss. sphenŏīdālis 6.
— nāsi 856.
— parvae oss. sphenŏīdālis 8.
— vōmĕris 28.
Almond nucleus 691.
Alveolar passages 585.
Alveŏli dentāles 31, 36.
— pulmōnis 585.
Ampūlla(ae) dūctus deferēntis 606.
— lacrimālis 822.
— membranacĕae 851.
— ossĕae 846.
— rēcti 546.
— tubae uterīnae 617.
Anastomotĭca magna 454.
— — artery 428.
Āngŭlus(i) acromĭi 101.
— costae 87.
— frontālis oss. parietālis 20.
— infrasternālis 91.
— īrĭdis 801, 807.
— mandibŭlae 37.
— mastoidēus oss. parietālis 20.
— occipitālis oss. parietālis 20.
— ocŭli 817, 818.
— parietālis oss. sphenŏīdālis 7.
— scapŭlae 100.
— sphenŏīdālis oss. parietālis [20.
— sterni 91.
Ankle joint, under 240.
— — upper 235.
Ānnŭlus(i) conjunctīvae 798.
— femorālis 343.
— fibrocartilaginĕus membrānae tȳmpăni 831.
— fibrōsus (fibrocartilagĭnis intervertebrālis) 175, 176.
Annŭli(us) fibrōsi [cordis] 391.
— haemorrhŏīdālis 547.
— inguinālis abdominālis 298, 301.
— — subcutānĕus 291, 298.
— īrĭdis major, minor 800.
— tendinĕus commūnis [Zinni] [810.
— tympanĭcus 16, 69.
— urethrālis 602, 615.
Ansa(ae) hypoglōssi 736.
— nn. spinālĭum 736.
— subclāvĭa [Vieussenii] 788.
Antebrāchĭum 110.
Anterior angle (of the shoulder blade) 100.
— bicipital ridge 94.
— carpal rete 435.
— choroid artery 418.
— circumflex artery 426.
— costovertebral or stellate ligament 189.
— dental branch 413.
— or external crucial ligament 224.
— fascicŭlus of external lateral ligament 236.
— interosseous artery 431.
— interventricular groove 367.
— layer of the triangular ligament, superficial or inferior triangular ligament 609.
— or lesser sacrosciatic ligament 212.

Anterior ligament (wrist-joint) 205.
— nares 64.
— occipitoatlantal ligaments 181.
— peroneal artery 456.
— radial carpal 430.
— and posterior chondrosternal ligaments 193.
— — — superior tibiofibular ligaments 234.
— surface 366.
— terminal branch 408, 410.
— tibiotarsal ligament 219.
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Antitrăgus 825.
Antrum of Highmore 29, 30.
— tympanĭcum 835.
Anus 546, 547.
Anvil 836.
Aōrta 405.
— abdominālis 438, 439.
— thoracālis 436.
Aortic arch 406.
— spindle 407.
Apertūra(ae) extērna aquaedūctus vestibŭli 11.
— extērna canalicŭli cochlĕae 11.
— canalicŭli tympanĭci 12, 13, 14.
— intērna aquaedūctus vestibŭli 844.
— laterālis ventrīcŭli quarti 655.
— mediālis ventrīcŭli quarti 655.
— pirifōrmis 29, 30, 64.
— sĭnus sphenŏīdālis 6.
— tympanĭca canalicŭli chordae 835.
Apex capitŭli fibŭlae 151.
— colūmnae posteriōris grīsĕae [641.
— cordis 383.
— linguae 507.
— nāsi 496, 856.
— ossis sacri 80.
— patēllae 149.
— pulmōnis 580.
— pyrămĭdis 11.
— rādīcis dentis 505.
— suprarenālis 603.
Aponeurōsis palmāris 335.
— plantāris 370.
Apparātus digestōrĭus 496.
— lacrimālis 794, 822.
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— epiplŏĭcae 544.
— fibrōsa hēpătis 550.
— testis [Morgagnii] 605.
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— vestibŭli 11, 844.
Aqueduct of Falloppius 14.
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Arachnoīdēa encephăli 706, 707.
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— pharyngopalatīnus 518.
— plantāris 458.
— postĕrĭor atlāntis 74.
— superciliāres 17.
— tārsēus inferĭor, supĕrĭor 417.
— tendinĕus fāscĭae pelvis 633.
— — m. levatōris āni 628.
— venōsus digitālis 469.
— — dorsālis manus 469.
— — — pedis [cutanĕus] 488.
— — jugŭli 468.
— — plantāris cutanĕus 488.
— — plantāris profūndus 487.
— vĕrtĕbrae 72.
— volāris profūndus 435.
— — superficiālis 434.
— — venōsus profūndus 469.
— — — superficiālis 469.
— zygomatĭcus 34.
Arĕa(ae) acūstĭca 650.
— cochlĕae 850.
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B.

List of the names

which occur in the Anatomical Nomenclature used

with short Biographical notes.

Achilles — tendo calcaneus

Arantius — ductus venosus
— ligamentum venosum
— nodulus valvulae semilunaris
Giulio Cesare Aranzi (Julius Caesar Arantius) (1530—1589), Professor of Medicine and Anatomy at Bologna.

Arnold — Arnold's bundle (Frontal [cerebro-] pontile path)
— substantia reticularis alba
Friedrich Arnold (1803—1890), Professor of Anatomy at Zürich, of Anatomy and Physiology at Freibourg, Tübingen and Heidelberg.

Bartholinus — glandula vestibularis major
Casparus Bartholinus (1655 till 1738), first Professor of Philosophy, then of Natural Science and Medicine, afterwards „Generalprocureur“ and Deputy of Finances in Copenhagen. He was the son of Thomas Bartholinus (1616 till 1680) who was generally considered to be the greatest anatomist of his time.

Bechterew — nucleus nervi vestibularis superior
Wladimir von Bechterew (1857 till 1927), Professor of Psychiatry at Kazan and St. Petersburg.

Bertin — columnae renales
Exupère-Joseph Bertin (1712 till 1781), Anatomist and Physiologist at Paris.

Blandin — glandula lingualis anterior
Philippe-Frédéric-Blandin (1798 till 1849), Professor of Surgery at Paris.

Bochdalek — trigonum lumbocostale
Victor Bochdalek junior (1835 till 1868), Prosector of anatomy at Prague.

Botallo — ductus arteriosus
Leonardo Botallo was born in 1530, Anatomist and Surgeon at Pavia and Paris.

Bowman — lamina elastica anterior corneae
Sir William Bowman (1816—1892), Professor of Anatomy and Physiology, also Oculist in London.

Breschet — canales diploici
Gilbert Breschet (1784—1845), Professor of Anatomy at Paris.

Broca — area parolfactoria
Paul Broca (1824—1880), Professor of Surgery at Paris; famous also as Anatomist, Anthropologist and Pathologist.

Bruecke — fibrae meridionales m. ciliaris
Ernst Wilhelm v. Bruecke (1819 till 1892), Professor of Physiology at Königsberg, of Physiology and Microscopic Anatomy at Vienna.

Brunner — glandulae duodenales
Johann Konrad Brunner (1653 till 1727), first Professor of Medicine at Heidelberg, then Physician to the Elector Palatine.

Burdach — funiculus cuneatus
Karl Friedrich Burdach (1776 till 1847), Professor of Anatomy and Physiology at Dorpat and Königsberg.

Chopart — articulatio tarsi transversa
François Chopart (1743—1795), Surgeon at Paris.

Civinini — processus pterygospinosus ossis sphenoidalis
Filippo Civinini died in 1844, Professor of Surgical Pathology and of Anatomy at Pistoia.

Clarke — nucleus dorsalis
Jacob Augustus Lockhart Clarke (1817—1880), Physician at London.

Cloquet — septum femorale
Jules-Germain Cloquet (1790 till 1883), Anatomist and Professor of Surgery at Paris.

Colles — ligamentum inguinale reflexum
Abraham Colles (1773—1843), Professor of Anatomy and Surgery at Dublin.

Cooper — fascia cremasterica
Sir Astley Paston Cooper (1768 till 1841), first Professor of Anatomy, then of Zoophysics, and finally of Surgery. Physician to King George IV. and to King William IV. in London.

Corti — organon spirale
Marchese Alfonso Corti (1822 till 1876), Physician, Hyrtl's Prosector in Vienna (1848), then he devoted mostly at Würzburg under Koelliker his time to research work. Afterwards he took up viticulture at his estate near Casteggio being compelled by ill health to give up his former work.

Cowper — glandulà bulbourethralis
William Cowper (1666—1709), Surgeon and Anatomist in London.

Darwin — tuberculum auriculae
Charles Robert Darwin (1809 till 1882), studied medicine, then theology and finally took up natural science. After a 5 years cruise round the world on the „Beagle" he devoted himself entirely to natural science and research at his estate in Kent.

Deiters — nucleus nervi vestibularis lateralis
Otto Friedrich Karl Deiters (1834 till 1863), Physician at Bonn.

Demours — lamina elastica posterior corneae
Pierre Demours (1702—1795), Oculist in Paris.

Descemet — lamina elastica posterior corneae
Jean Descemet (1732—1810), Physician and Botanist in Paris.

Douglas — cavum Douglasi (excavatio rectouterina)
— linea semicircularis
— plica rectouterina
James Douglas (1675—1742), Physician in London.

Eustachius — tuba auditiva
— valvula venae cavae
Bartolomeo Eustachi was born between 1500 and 1510 and died in 1574. Professor of Anatomy at Rome.

Falloppio — canalis facialis
— tuba uterina
Gabriele Falloppio (1523—1562), Professor of Anatomy at Ferrara, Pisa, and of Anatomy and Botany at Padua.

Ferrein — processus Ferreini (pars radiata lobuli corticalis renis)
Antoine Ferrein (1692—1769), Professor of Medicine and Surgery in Paris.

Flechsig — fasciculus anterior proprius
— fasciculus lateralis proprius
— nucleus nervi vestibularis superior
Paul Emil Flechsig was born in 1847, Professor of Psychiatry at Leipzig.

Folius — processus anterior mallei
Cecilio Folli (Folius) was born in 1615 and died about 1650; Professor of Anatomy at Venice.

Fontana — spatia anguli iridis
Felice Fontana (1720—1805), Professor of Philosophy at Pisa and afterwards Director of the Museum of Natural Science in Florence.

Galenus — vena cerebri magna
Galenos was born in 129 A. D. at Pergamon. Resided as Physician and successful writer on medical topics in Rome. Physician to the Emperor Commodus. He died at the beginning of the 3rd century.

Gartner — ductus epoophori longitudinalis
Hermann Treschow Gartner (1785 till 1827), Physician in Copenhagen.

Gasser — ganglion semilunare
Johann Ludwig (or Laurenz) Gasser was Professor of Anatomy in Vienna in the middle of the 18th century.

Gennari — linea Gennari
Francesco Gennari lived in the second half of the 18th century. His book „De peculiari structura cerebri" was published at Parma in 1782.

Gimbernat — ligamentum lacunare
Don Antonio de Gimbernat was professor at Barcelona in the second half of the 18th century; afterwards he was appointed Physician to King Charles III. in Madrid.

Glaser — fissura petrotympanica
Johann Heinrich Glaser (1629 till 1675), was Professor of Anatomy and Botany at Basel.

Goll — funiculus gracilis
Friedrich Goll (1829—1903), Professor of Pharmacology at Zürich.

Gowers — fasciculus anterolateralis superficialis
William Richard Gowers was born in 1845 and was Professor of Clinical Medicine in London.

Graaf — folliculi oophori vesiculosi
Reinier de Graaf (1641—1673), Physician at Delft.

Gratiolet — radiatio occipitothalamica
Louis Pierre Gratiolet (1815 till 1865), first Professor of Anatomy and subsequently Professor of Zoology in Paris.

Haller — arcus lumbocostales
— circulus vasculosus n. optici
— rete testis
Albrecht von Haller (1708—1777), Professor of Anatomy, Surgery and Botany at Göttingen. In later years he resided at Bern, his native town. Haller was not only an eminent scientist, but he was also famous as a poet.

Hasner — plica lacrimalis
Josef Hasner, Ritter von Artha (1819—1892), Professor of Ophthalmology at Prague.

Havers — Haversian canals of bone
Clopton Havers, an English Anatomist, lived in London in the second half of the seventeenth century and at the beginning of the eighteenth century.

Heister — valvula spiralis
Lorenz Heister (1683—1758), Professor of Anatomy and Botany at Altdorf, Professor of Surgery and Botany at Helmstädt.

Helweg — Helweg's bundle
Hans Kristian Saxtorph Helweg (1847—1901), Head Physician of the Oringe Lunatic Asylum near Vordingborg (Sealand, Denmark).

Hensen — ductus reuniens
Victor Hensen (1835—1924), Professor of Physiology at Kiel.

Hesselbach — ligamentum interfoveolare
Franz Kaspar Hesselbach (1759 till 1816), Anatomist and Surgeon at Würzburg.

Highmore — corpus Highmori (mediastinum testis)
Nathanael Highmore (1613—1685), Physician at Sherburn (Dorsetshire).

Horner — pars lacrimalis m. orbicularis oculi
William Edmonds Horner (1793 till 1853), Professor of Anatomy at Philadelphia.

Hunter — canalis adductorius
John Hunter (1728—1793), Surgeon in London.

Jacobson — plexus tympanicus
— cartilago vomeronasalis
— organon vomeronasale
Ludwig Levin Jacobson (1783 till 1843), Physician in Copenhagen, afterwards Army Surgeon with the French armies and after the Battle of Leipzig with the English-Hanoverian Legion.

Kerckring — plicae circulares
Theodorus Kerckring (1640—1693), Physician in Amsterdam and afterwards „Resident to the Duke of Tuscany" at Hamburg.

Krause — glandulae mucosae conjunctivae
Karl Friedrich Theodor Krause (1797—1868), Professor of Anatomy at Hannover.

Lauth — canalis Lauthi (sinus venosus sclerae)
Ernst Alexander Lauth (1803 till 1837), Professor of Physiology and Head of the Anatomical Preparations in the Medical Faculty at Strassburg.

Lieberkühn — glandulae intestinales
Johann Nathanael Lieberkühn (1711—1756), Physician in Berlin.

Lieutaud — trigonum vesicae
Joseph Lieutaud (1703—1780), first Physician at Aix, afterwards appointed Physician to Louis XV. and Louis XVI. at Versailles.

Lisfranc — articulationes tarsometatarseae
— tuberculum scaleni
Jacques Lisfranc (1790—1847), Professor of Surgery in Paris.

Lissauer — Lissauer's marginal zone of the spinal cord
Heinrich Lissauer (1861—1891), Assistant Physician at the Breslau University Hospital for Psychiatry.

Littre — glandulae urethrales
Alexis Littre (1658—1726), Anatomist and Surgeon in Paris.

Lower — tuberculum intervenosum
Richard Lower (1631—1691), Physician in London.

Luys — corpus Luysi (nucleus hypothalamicus)
Jules-Bernard Luys (1828—1897), Physician in Paris.

Magendie — foramen Magendii (apertura medialis ventriculi quarti)
François Magendie (1783—1855), Physician and Professor of Physiology and Pathology in Paris.

Maissiat — tractus iliotibialis
Jacques-Henri Maissiat (1805 till 1878), Physician, Professor in Paris; Conservateur en chef at the Museum of the Ecole de médecine.

Malpighi — pyramides renales
Marcello Malpighi (1628—1694), Professor of Medicine at Bologna, Pisa and Messina, finally Physician to Pope Innocence XII. at Rome. Malpighi is the originator of microscopic anatomy.

Marshall — vena obliqua atrii sinistri
John Marshall (1818—1891), Professor of Surgery and Anatomy in London.

Meckel — Meckel's cartilage
Johann Friedrich Meckel the Younger, (1781—1833), Professor of Anatomy and Surgery at Halle.

Meibom — glandulae tarsales
Heinrich Meibom (1638—1700), Professor of Medicine, History and Poetry at Helmstädt.

Meynert — fasciculus retroflexus
Theodor Meynert (1833—1892), Professor of Neuropathology in Vienna.

Moll — glandulae ciliares
Jacob Anton Moll (1832—1914), Oculist at the Hague (Netherlands).

Monro — foramen interventriculare
— sulcus hypothalamicus
Alexander Monro (Tertius) (1773 till 1859), Professor of Anatomy and Surgery at Edinburgh.

Montgomery — glandulae areolares
William Fetherston Montgomery was born about 1797 and died in 1859, Obstetrician in Dublin.

Morgagni — appendices vesiculosae epoophori
— appendix testis
— columnae rectales
— foramen caecum linguae
— fossa navicularis urethrae
— lacunae urethrales
— ventriculus laryngis
Giovanni Battista Morgagni (1682—1771), Professor of Anatomy at Padua.

Müller — fibrae circulares m. ciliaris
Heinrich Müller (1820—1864), Professor of Anatomy at Würzburg.

Müller — Müller's duct
Johannes Müller (1801—1858), Professor of Anatomy and Physiology in Berlin.

Nuhn — glandula lingualis anterior
Anton Nuhn (1814—1889), Professor of Anatomy at Heidelberg.

Pacchioni — foveolae granulares
— granulationes arachnoideales
Antonio Pacchioni (1665—1726), Anatomist in Rome.

Pacini — corpuscula lamellosa
Filippo Pacini (1812—1883), Professor of Anatomy at Florence.

Petit — trigonum lumbale
Jean-Louis Petit (1674—1760), Surgeon in Paris.

Peyer — noduli lymphatici aggregati
Johann Konrad Peyer (1653—1712), Physician and subsequently Professor of Rhetoric and Natural Science at Schaffhausen.

Poupart — ligamentum inguinale
François Poupart (1616—1708), Surgeon in Paris, Physician to Lady Maintenon in the reign of Louis XIV.

Purkinje — stratum gangliosum cerebelli
Johannes Evangelista Ritter von Purkinje (1787—1869), Professor of Physiology and Pathology at Breslau, of Physiology at Prague.

Rathke — Rathke's pouch
Martin Heinrich Rathke (1793 till 1860), first Professor of Physiology and Pathology at Dorpat, then of Zoology and Anatomy at Königsberg.

Reil — sulcus circularis insulae
Johann Christian Reil (1759 till 1813), Professor of Clinical Medicine at Halle and in Berlin.

Reißner — membrana vestibularis
Ernst Reißner (1824—1878), Professor of Anatomy at Dorpat.

Riolan — musculus ciliaris
Jean Riolan, the son, (1580—1657), Professor of Anatomy, Botany and Pharmacology in Paris, Physician to Henry IV. and to Louis XIII, Head-physician of the Queen-Mother Maria of Medici.

Rivinus — incisura tympanica
August Quirinus Rivinus (1652 till 1723), first Professor of Physiology and Botany, then of Pathology and finally of Therapeutics at Leipzig. Known for his classification of plants.

Rolando — substantia gelatinosa
— sulcus centralis
Luigi Rolando (1773—1831), Physician to King Victor Emanuel of Sardinia, Professor of Medicine at Sassari, of Anatomy at Turin.

Rosenmüller — recessus pharyngeus
Johann Christian Rosenmüller (1771—1820), Professor of Anatomy at Leipzig.

Santorinus — cartilago corniculata
— concha nasalis suprema
— ductus pancreaticus accessorius
— incisurae cartilaginis meatus acustici externi
— papilla duodeni
— tuberculum corniculatum
Giovanni Domenico Santorini (1681—1737), Professor of Anatomy at Venice.

Sappey — venae parumbilicales
Marie-Philibert-Constant Sappey (1810—1896), Professor of Anatomy at Paris.

Scarpa — fossa Scarpae major (trigonum femorale)
— nervus nasopalatinus
Antonio Scarpa (1752—1832), Professor of Anatomy and Surgery first at Modena, then at Pavia, finally Professor of Surgery at Pavia.

Schlemm — canalis Schlemmi (sinus venosus sclerae)
Friedrich Schlemm (1795—1858), Professor of Anatomy in Berlin.

Schwalbe — nucleus nervi vestibularis medialis
Gustav Schwalbe (1844—1916), Professor of Anatomy at Leipzig, Jena, Königsberg and Strassburg.

Spigelius — linea semilunaris
— lobus caudatus
Adrian van den Spieghel (Spigelius), (1578—1625), Professor of Anatomy and Surgery at Padua.

Stenonis — ductus parotideus
— Stensen's passage
Niels Stensen (Nicolaus Stenonis, alias Steno, alias Stenonius), was born in Copenhagen in 1638, wrote (usually in Italy) on anatomical, physiological and geological topics, was appointed Physician to the Grand-Duke Ferdinand II. of Tuscany, turned Roman Catholic in 1667, was Professor of Anatomy in Copenhagen from 1672 till 1674, in 1675 he was ordained a priest at Florence, in 1677 he journeyed as „Bishop of Titiopolis" to Münster, Hanover and Brunswick with the intention of winning back the North for the Church of Rome. He died in 1686 at Schwerin. He was buried in the Medicean Vault at St. Lorenzo in Florence by order of the Grand-Duke Cosimo.

Stilling — nucleus dorsalis medullae spinalis
Benedict Stilling (1810—1879), Surgeon and Anatomist at Cassel.

Sylvius — aquaeductus cerebri
— fissura cerebri lateralis
— fossa cerebri lateralis
Franz de le Boë (Sylvius) (1614 till 1672), first Physician in Amsterdam, then Professor at Leyden.

Tarin — fossa interpeduncularis
Pierre Tarin (was born about 1725, and died in 1761), Anatomist in Paris.

Tawara — Tawara's node
Sunao Tawara was born in 1875. Professor of the Pathological Institute in the Imperial University at Kyushu (Japan).

Tenon — fascia bulbi
— spatium interfasciale
Jacques-René Tenon (1724—1816), Surgeon and Oculist, Professor of Pathology in Paris.

Thebesius — foramina venarum minimarum
— valvula sinus coronarii
Adam Christian Thebesius, lived at the close of the 17th and at the beginning of the 18th century, Physician at Hirschberg (Silesia).

Türck — Türck's bundle (Temporal [cerebro-] pontile path)
Ludwig Türck (1810—1868), Neurologist and Laryngologist in Vienna.

Valsalva — ligamenta auricularia
— sinus aortae
Antonio Maria Valsalva (1666 till 1723), Professor of Anatomy and Surgeon at Bologna.

Varolio — pons
Costanzo Varolio (1543—1575), Professor of Anatomy and Surgery at Bologna, Professor at Rome, Physician to Gregor XIII.

Vater — corpuscula lamellosa
Abraham Vater (1684—1751), Professor of Anatomy, finally of Therapeutics at Wittenberg.

Vicq d'Azyr — fasciculus thalamomamillaris
Felix Vicq-d'Azyr (1748—1794), Physician in Paris, published works especially on Anatomy and Zoophysics.

Vidius — canalis pterygoideus
— arteria, nervus, vena canalis pterygoidei
Guido Guidi (Lat. Vidus Vidius), was born at the beginning of the sixteenth century, was Appointed Physician to Francis I. and Professor of Medicine in Paris, then Professor of Philosophy and Medicine at Pisa where he died in 1569.

Vieussens — ansa subclavia
— limbus fossae ovalis
Raymond de Vieussens (1641 till 1716), Physician at Montpellier, from time to time in Paris.

Wharton — ductus submaxillaris
Thomas Wharton (1610—1673), Physician in London.

Willis — circulus arteriosus
Thomas Willis (1621—1675), first Professor of Natural Science at Oxford, afterwards Physician in London.

Winslow — foramen epiploicum
— pancreas Winslowi (processus uncinatus pancreatis)
Jakob Benignus Winslow (1669 till 1760), Professor of Anatomy in Paris.

Wirsung — ductus pancreaticus
Johann Georg Wirsung was born in 1600 at München; he was assassinated in 1643; 5 years Prosector at Padua.

Wrisberg — cartilago cuneiformis
— ganglion cardiacum
— tuberculum cuneiforme
Heinrich August Wrisberg (1739 till 1808), Professor of Anatomy at Göttingen.

Zinn — annulus tendineus communis
— zonula ciliaris
Johann Gottfried Zinn (1727 till 1759), Professor of Medicine and Director of the Botanical Garden in Göttingen.

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